NATIONAL ASSOCIATION

OF

CEMENT USERS

PROCEEDINGS

OF THE

THIRD ANNUAL CONVENTION

Held at Chicago, Illinois,

January 7, 8, 9, 10, 11, 12, 1907

VOLUME III

EDITED BY THE PRESIDENT

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1907

The Association is not responsible, as a body, for the statements and opinions advanced in its publications.

Transport.

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T. L. CONDRON, *Chairman.*
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H. C. TURNER.
C. A. P. TURNER.

CHARTER
OF
THE NATIONAL ASSOCIATION OF CEMENT USERS.

KNOW ALL MEN BY THESE PRESENTS, That we, the undersigned, all of whom are citizens of the United States, and a majority of whom are residents of the District of Columbia, have associated ourselves together for the purpose hereinafter set forth and desiring that we may be incorporated as an Association under sub-chapter three (3) of the Incorporation Laws of the District of Columbia, as provided in the Code of Law of the District of Columbia, enacted by Congress and approved by the President of the United States, do hereby certify:

1. Name. The name of the proposed corporation is "The National Association of Cement Users."

2. Term of Existence. The existence of the said corporation shall be perpetual.

3. Objects. The particular business and objects of the said corporation shall be to disseminate information and experience upon and to promote the best methods to be employed in the various uses of cement by means of convention, the reading and discussion of papers upon materials of a cement nature and their uses, by social and friendly intercourse at such conventions, the exhibition and study of materials, machinery and methods and to circulate among its members by means of publications the information thus obtained.

4. Incorporators. The number of its managers for the first year shall be fifteen.

In Witness Whereof, we have hereunto set our hands and seals this fourteenth day of December, A. D. 1906.

RICHARD L. HUMPHREY, (SEAL)
JOHN STEPHEN SEWELL, (SEAL)
S. S. VOORHEES. (SEAL)

OFFICE OF RECORDER OF DEEDS,
DISTRICT OF COLUMBIA.

This is to certify that the foregoing is a true and verified copy of a Certificate of Incorporation, and of the whole of such Certificate as received for record in this office at 9.49 a. m., the 19th day of December, A. D. 1906.

In testimony whereof I have hereunto set my hand and affixed the seal of this office, this 20th day of December, A. D. 1906.

(Signed) R. W. DUTTON,
Deputy Recorder of Deeds,
(SEAL) *District of Columbia.*

BY-LAWS
OF
THE NATIONAL ASSOCIATION OF CEMENT USERS.

ARTICLE I.

MEMBERS.

SECTION 1. Any company or persons engaged in the construction or maintenance of work in which cement is used, or qualified by business relations or practical experience to co-operate in the purposes of this Association, or engaged in the manufacture or sale of machinery or supplies for cement users, or a man who has attained eminence in the field of engineering, architecture or applied science, is eligible for membership.

SEC. 2. A company shall be treated as a single member and allowed but one vote.

SEC. 3. Application for membership shall be made to the Secretary on a form prescribed by the Executive Board. The Secretary shall submit a copy of the same to each member of the Executive Board and a two-thirds majority of those present at a Board meeting shall be necessary to an election.

SEC. 4. Resignations from membership must be transmitted in writing to the Secretary.

SEC. 5. Any member, after a fair hearing by first the Executive Board and then, with their approval, by this Association, shall be expelled from membership by a three-fourths ballot of the members present at any regular meeting of the Association, not less than twenty votes being cast. Such action shall be publicly announced.

ARTICLE II.

OFFICERS.

SECTION 1. The officers shall be a President, four general Vice-Presidents, a Vice-President for each section into which the Association may be divided, a Secretary and a Treasurer.

SEC. 2. These officers, except the Secretary and Treasurer, shall be elected by ballot at the Annual Meeting and shall hold office for one year. The Secretary and Treasurer shall be elected annually by the Executive Board. Vacancies occurring during the year shall be filled by the Executive Board.

SEC. 3. The Executive Board shall consist of these officers and the five latest living Past-Presidents.

SEC. 4. The Secretary shall be custodian of the Association property and shall forward all moneys received to the Treasurer, obtaining his receipt for the same. He shall give such bond as the Executive Board may require.

SEC. 5. The Treasurer shall handle the funds of the Association subject to the approval of the Executive Board and shall give bond for the faithful performance of his duties in such sum as the Executive Board may designate. The Treasurer shall disburse funds only on warrant drawn by the Secretary and countersigned by the President.

SEC. 6. It shall be the duty of the Executive Board to audit the accounts of the Secretary and Treasurer before each annual meeting.

SEC. 7. The Secretary and Treasurer shall receive a salary to be fixed by the Executive Board.

SEC. 8. The Association shall be divided into such sections as the Executive Board may determine by the enrollment of members of the Association in such sections as they may choose. The Chairmen of these sections shall be elected by the sections at the first section meeting provided on the programme of the Annual Convention, and shall be reported to the Association for election as Vice-Presidents of the Association at the general election. Standing committees of four additional members each shall be appointed by the President of the Association in consultation with the respective chairmen to aid them in their work.

SEC. 9. At the first regular session of the Annual Convention, the President shall appoint a committee on nomination of officers, and a committee on resolutions.

SEC. 10. The election of officers shall take place at the business session on the second day of the convention, and they shall assume office at the close of the convention and hold same until their successors are elected and qualified.

ARTICLE III.

MEETINGS.

SECTION 1. The Association shall meet annually, the time and place being determined by the Executive Board, and notice shall be mailed to all members at least twenty days previous to the date of meeting.

ARTICLE IV.

DUES.

SECTION 1. The fiscal year shall commence on the first of January and all dues shall be payable in advance.

SEC. 2. The annual dues of each member shall be five dollars ($5.00).

SEC. 3. Any member whose dues shall remain unpaid for one year shall forfeit the privilege of membership. If he neglects to pay his dues within thirty days thereafter and after notification from the Secretary, his name may be stricken from the roll of membership by the Executive Board.

SEC. 4. Upon the payment of a fee of two ($2.00) dollars any person may attend the Annual Convention of the Association and enjoy all its privileges except the right to vote.

ARTICLE V.

AMENDMENTS.

SECTION 1. Proposed amendments to these By-Laws signed by at least three members, must be presented in writing to the Executive Board before November 1st of each year. In the notices for this meeting the proposed amendment shall be printed. At the annual meeting the proposed amendment may be discussed and amended and may be passed to letter-ballot by a two-thirds vote of those present. If two-thirds of the votes obtained by letter-ballot are in favor of the proposed amendment, it shall be adopted.

SEC. 2. The Executive Board is authorized to number the articles and sections of the By-Laws to correspond with any changes that may be made.

SUMMARY OF PROCEEDINGS OF THE THIRD CONVENTION.

FIRST SESSION.—TUESDAY, JANUARY 8, 1907, 10.00 A. M.

President Richard L. Humphrey in the chair.

The President appointed the following committees:

Committee on Nominations:

C. W. Boynton, Chairman, Chicago, Illinois.
J. W. Panushka, New Orleans, Louisiana.
C. L. Johnson, Castalia, Ohio.
Sanford E. Thompson, Newton Highlands, Massachusetts.
M. Wetzstein, South Bend, Indiana.

Committee on Resolutions:

J. W. Pierson, East Orange, New Jersey.
Charles C. Brown, Indianapolis, Indiana.
William Dickinson, Chicago, Illinois.
H. H. Rice, Denver Colorado.
A. Monsted, Milwaukee, Wisconsin.

Mr. H. C. Miller, of New York, was appointed to the Committee on Resolutions, to succeed Mr. J. W. Pierson, who resigned.

The report of the Committee on Streets, Sidewalks and Floors, George L. Stanley, Chairman, was discussed.

The following paper was read and discussed:

"Cement Sidewalk Paving," Albert Moyer.

The meeting then adjourned until 8.00 P. M.

SECOND SESSION.—TUESDAY, JANUARY 8, 1907, 8.00 P. M.

President Richard L. Humphrey in the chair.

The annual address was delivered by the President.

The following papers were read and discussed:

"The Mechanics of Reinforced Concrete," W. K. Hatt.

"Forms for Concrete Construction," Sanford E. Thompson.

The meeting then adjourned till Wednesday at 10.00 A. M.

WEDNESDAY, JANUARY 9, 1907, 9.00 A. M.

Meeting of Section on Concrete Blocks and Cement Products.

Mr. M. S. Daniels in the chair.

The session was devoted to a topical discussion on the manufacture of concrete blocks.

The meeting adjourned at 10.00 A: M.

THIRD SESSION.—WEDNESDAY JANUARY 9, 1907, 10.00 A. M.

President Richard L. Humphrey in the chair.

The following papers were read and discussed:

"Selecting the Proportions for Concrete," William B. Fuller.

"Report Committee on Testing Cement and Cement Products," E. S. Larned, Chairman.

It was moved, seconded and adopted that the Committee on Resolutions be instructed to report a resolution covering the recommendation of the Committee on Testing Cement and Cement Products, which read as follows: "We recommend the appointment of a Committee on Specifications, consisting of the President of this Association, ex-officio; the Vice-President and members of the Section on Testing Cement and Cement Products, and the Vice-Presidents of each of the following named sections, viz.: Concrete Blocks and Cement Products, Streets, Sidewalks and Floors; Reinforced Concrete, Art and Architecture, Machinery for Cement Users, Fireproofing and Insurance, and Laws and Ordinances.

"The above committee to meet and organize before the close of this convention, and a copy of their report and recommendations to be prepared and sent to each member of this Association on or before the first day of June, 1907."

The meeting was then declared a business session.

The report of the Executive Board and the minutes of the meetings of the Executive Board were adopted as read.

The following resolution was adopted:

WHEREAS, It appears from the report of the Executive Board presented to this Association that, after the payment of all the

obligations of the Association for the year 1906, there still remains a balance in the treasury of the Association,

WHEREAS, The National Association of Cement Users desire to record the appreciation of the services rendered it by the President, Mr. Richard L. Humphrey; by the Secretary, Mr. Charles C. Brown, and the members of the Executive Board, who successfully directed the affairs of the Association this far;

THEREFORE, Providing that there shall be in the Treasury a sufficient sum for the purpose hereinafter specified; be it

Resolved, First, That the treasurer be and is hereby directed to pay to Mr. Richard L Humphrey and to Mr. Charles Carroll Brown an honorarium of three hundred dollars ($3.00.00), respectively; and, second, that the Treasurer shall reimburse the members of the Executive Board for their actual traveling and hotel expenses in attending upon the meetings of the Executive Board during the fiscal year 1906, and in the future the Treasurer shall pay from the funds of the Association the actual traveling and hotel expenses of the members of the Executive Board in attending its meetings, with the exception of those meetings held at the annual convention, when approved by the President and Secretary; and, be it further

Resolved, That we recommend to the Executive Board that it shall hold its meetings at such places as will mean the least expense to the Association, and to further reduce the expense, to arrange, when possible, for an executive committee of its own members to transact the necessary business of the Association, the acts of such Executive Committee to be subject to the approval of the full Executive Board at its next meeting and be recorded in its minutes.

It was resolved that the selection of the place for the next annual convention be referred to the Executive Board with power to act.

Upon the recommendation of the Committee on Nominations, the following officers were unanimously re-elected, the Secretary casting the ballot:

President, Richard L. Humphrey, Philadelphia, Pennsylvania.

First Vice-President, Merrill Watson, New York, New York.

Third Vice-President, O. U. Miracle, Minneapolis, Minnesota.

Fourth Vice-President, A. Monsted, Milwaukee, Wisconsin.

On the same ballot M. S. Daniels, Suffern, N. Y., was elected Second Vice-President, to succeed Mr. Fellows, who retired because of ill health.

It was moved, seconded and adopted that the President instruct the Executive Board to appoint a committee as recommended by the Committee on Testing Cement and Cement Products.

The Executive Board was instructed to appoint a Committee on Waterproofing.

The meeting then adjourned until 8.00 P. M.

FOURTH SESSION.—WEDNESDAY, JANUARY 9, 1907, 8.00 P. M.

President Richard L. Humphrey in the chair.

The following papers were read and discussed:

"Artistic Treatment of Concrete," A. O. Elzner.

"Concrete Surfaces," H. H. Quimby.

"Treatment of Concrete Surfaces," Lynn White.

The Committee on Art and Architecture, Charles D. Watson, chairman, presented its report.

The meeting adjourned until Thursday at 10.00 A. M.

THURSDAY, JANUARY 10, 1907, 9.00 A. M.

Meeting of Section on Streets, Sidewalks and Floors, and Reinforced Concrete.

President Richard L. Humphrey requested Mr. G. L. Stanley, Vice-President of the Section on Streets, Sidewalks and Floors, to take the chair.

The session was devoted to a topical discussion on sidewalk construction.

FIFTH SESSION.—THURSDAY, JANUARY 10, 1907, 10.00 A. M.

President Richard L. Humphrey in the chair.

It was resolved that the Vice-President of the Section on Streets Sidewalks and Floors be instructed to prepare specifications for sidewalks to be submitted to every member of the Association by June 1, 1907.

Mr. H. H. Rice read a paper entitled "Concrete Blocks," which was followed by a discussion by Spencer B. Newberry on the manufacture of concrete blocks.

The following papers were read and discussed:

"Tests of Building Block," R. D. Kneale.

"Report of Committee on Machinery for Cement Users," J. F. Angell, Chairman.

The meeting was then adjourned until 8.00 P. M.

SIXTH SESSION.—THURSDAY, JANUARY 10, 1907, 8.00 P. M.

President Richard L. Humphrey in the chair.

The following sections reported the result of their elections for chairmen:

Section on Reinforced Concrete, T. L. Condron.

Section on Machinery for Cement Users, M. Wetzstein.

Section on Streets, Sidewalks and Floors, George L. Stanley.

Section on Art and Architecture, Charles D. Watson.

Section on Concrete Blocks and Cement Products, Spencer B. Newberry.

The session was devoted to a topical discussion on the manufacture of concrete blocks.

The meeting was then adjourned until Friday, 10.00 A. M.

FRIDAY, JANUARY 11, 1907, 9.00 A. M.

Meeting of the Section on Testing Cement and Cement Products.

President Richard L. Humphrey in the chair.

The session was devoted to a discussion on concrete blocks and sidewalk construction.

The meeting adjourned at 10.00 A. M.

SEVENTH SESSION.—FRIDAY, JANUARY 11, 1907, 10.00 A. M.

President Richard L. Humphrey in the chair.

The following papers were read and discussed:

"Waterproofing Cement Mortars and Concretes," The Asphalt Mastic Method, H. Weiderhold.

"Waterproofing Cement Mortars and Concretes," The Membrane Method, Edward DeKnight.

"Waterproofing Cement Mortars and Concretes," The Dry Powder Method, R. R. Fish.

"Waterproofing Cement Mortars and Concretes," The Liquid Method, G. F. Fry.

"Waterproofing Cement Mortars and Concretes," The Hydro-carbon Paint Method, S. J. Binswanger.

The convention then adjourned until 8.00 P. M.

EIGHTH SESSION.—FRIDAY, JANUARY 11, 1907, 8.00 P. M.

President Richard L. Humphrey in the chair.

The reports of the following committees were read, accepted and placed on file: Report of the Committee on Fireproofing and Insurance, E. T. Cairns, Chairman. Report of the Committee on Laws and Ordinances, H. C. Henley, Chairman.

The latter report was referred to the Specification Committee, which was appointed by the Executive Committee in pursuance of the resolution recommended in the report of the Committee on Testing Cement and Cement Products and adopted by the convention.

President Humphrey presented an illustrated paper on the work being done at the Structural Materials Testing Laboratories in St. Louis, Missouri.

The following resolutions were presented by the Committee on Resolutions and adopted by the Convention:

1. RESOLVED That the Executive Board be instructed to take the necessary steps under the by-laws to amend the same in the section regarding the selection of the secretary by adding to the by-laws, in the proper place, the provision that the Executive Board shall secure the services of a secretary, and that they be authorized to fix the compensation for such services.

2. WHEREAS, There is lack of accurate information on the properties of cement mortar and concrete, and

WHEREAS, The investigations being carried on by the United States Geological Survey are such that will supply this information,

We, the members of the National Association of Cement Users, in convention assembled at Chicago, Illinois, January 11, 1907, do hereby express our great appreciation of this excellent work under the direction of the United States Geological Survey, and we further believe the results so far obtained are of inestimable and far-reaching value; therefore,

Be it resolved, That the Congress of the United States be requested to continue the annual appropriation for this work, so that it may be completed.

3. *Resolved,* That this Association in convention assembled express its thanks and appreciation of the work done by the gentlemen who contributed valuable papers which were read before the convention and which added so much to the interest and permanent value of the program.

4. *Resolved,* That the Association also express its appreciation for the able assistance and co-operation to the officers and the Executive Board in arranging for the general program of the third convention, and especially do we thank the members of the local committee in the city of Chicago, and the technical press throughout the country, who, by generous space in their columns, added to the widespread interest in the convention.

The following resolutions were adopted:

1. *Resolved,* That the by-laws be so amended as to provide for only a $5.00 membership, each member, whether an individual or a corporation, to have but one vote.

2. *Resolved,* That the Executive Board be requested to consider the advisability of reporting an amendment to the By-laws providing for the appointment of the Committee on Nominations and Resolutions by the Executive Board to be announced on the first day of the convention.

The convention was then adjourned *sine die.*

NATIONAL ASSOCIATION OF CEMENT USERS.

PROCEEDINGS
OF THE
THIRD CONVENTION.

This Association is not responsible, as a body, for the statements and opinions advanced in its publications.

THE SUCCESSES AND FAILURES OF CEMENT CONSTRUCTION.

ANNUAL ADDRESS BY THE PRESIDENT,
RICHARD L. HUMPHREY, M.AM.SOC.C.E.*

We are indeed in the age of cement, and it is apparent that this infant industry which burst its swaddling clothes but a few years ago has become a lusty youngster—its growth outstripping the dream of its most ardent supporters.

We are passing through an era of unparalleled prosperity which has occasioned an activity in the world of construction demanding enormous quantities of cement, thus advancing the yearly consumption to figures which are a hundredfold greater than those of a dozen years ago.

When Germany, our principal competitor, topped a yearly production of 20,000,000 barrels, we regarded it as wonderful, yet a half dozen years later our own production has doubled these figures and we now are the largest cement producing country of the world.

It is hard for even the cement user to follow the meteoric progress of the production and consumption of cement. A prog-

*Consulting Engineer, Harrison Building, Philadelphia, Pa.

ress so rapid that the friends of this material of construction must needs pause and consider the danger which may await a too rapid pace.

It was my pleasure a year ago to address this Association on the development of the industry and to indicate some of the uses to which cement was put. I shall utilize the time allotted for this address in pointing out the features of the great test—the San Francisco earthquake—which served to further establish some of its intrinsic qualities as a building material and to further point out some of the abuses to which it is subjected, which often result in failures of the structures in which it is used and which tends to retard the progressive development in its use.

As I took occasion to remark a year ago, cement has its weaknesses and limitations, and these should be faced squarely by its advocates and pointed out emphatically, in order to prevent abuse which tends to dim its unsurpassed qualities.

Of the materials of construction cement is at once the most delicate and the most valuable—a plastic material, whose properties we are only just beginning to appreciate and understand.

Its extensive use is not because its qualities are well developed and recognized, but because its cheapness renders it an effective competitor of other building materials both in strength and fire-resisting qualities.

Great catastrophes and overwhelming disasters of all kinds, while resulting in great hardship and suffering, teach lessons of incalculable value. On the 18th of April of last year the entire civilized world stood aghast at the appalling destruction which visited the city of San Francisco and vicinity—the result of a slip of the earth's crust.

To the constructor and user of the materials of construction the most interesting feature was the behavior of the various materials of construction under those unusual and rigorous conditions. This was a test of such unusual violence that only the structure begotten of first-class materials and design and honest workmanship could survive.

Flimsy and loosely erected structures were shaken to the earth and collapsed like houses of cards under the terrific wrenching and shaking of the earth.

Those structures which survived the earthquake test were, in many cases, subjected to a fire test exceeding in its intensity all the great conflagrations of recent years.

Many structures which successfully withstood the first test failed signally under the test which followed by reason of the inadequate fireproofing. Other structures failed under both tests, while a very few withstood both tests successfully.

The study of the relative efficiency of the various materials of construction under these conditions is most interesting. It is a generally accepted fact that no structure could withstand the stress produced by the movement of the earth on the "fault line." The effect of the shaking and vibrations of the earth in the territory affected could be resisted, and the secret is proper design, first-class materials and honest workmanship. In tall structures rigidity of construction and stiffness, the result of adequate wind and portal bracing, is absolutely essential. While reinforced concrete structures in the zone of seismic disturbance were few, these passed the test in a highly, satisfactory manner. Rigidity and stiffness and a high fire resistance, which are inherent qualities of this material, demonstrated how admirably they were suited to resist this extraordinary test.

This test seems to be greatest for structures built in low lands—on alluvial soil in the valleys of rivers—where the settlement of the earth under the earthquake vibrations was very great. On solid ground and rock formations the test was much less severe. Structures at points of great destruction such as Palo Alto, San José, Salinas, Santa Rosa, etc., were built on soft material. The buildings of Stanford University suffered severely, most of them being wholly or partly destroyed by the earthquake shock. The types of construction represented were stone, brick and stone veneer and concrete.

The buildings of the latter type passed the ordeal successfully and demonstrated the superior qualities of a material possessing great adhesive qualities.

The great concrete dam at Crystal Springs Reservoir gave additional proof of the substantial qualities of concrete, for, although within a few hundred feet of the fault line, it suffered no damage.

At Palo Alto and Santa Rosa the failure of concrete block buildings have been pointed out as examples of the failure of cement to withstand the test. At Palo Alto three cement block buildings collapsed. No other result could have been expected when the method of construction is considered. The blocks were laid up without a tie of any kind, and the floor joists and roof timbers either rested on or were built into wall without any tie.

Under the movements of the earth the walls were pushed out of line, the wooden members of the structure not being tied to the walls, there was no means of restoring the wall to its former position and it collapsed. In one of the buildings the gable end of the roof rested against the wall and served as a battering ram.

That such structures can be so built as to withstand earthquake shocks is evidenced by the building at Santa Rosa also built of cement blocks, but differing from those just referred to in that iron tie rods held the walls tightly to the floor joists and roof timbers. While the neighboring brick, stone and frame structures collapsed, this building was but slightly damaged along the cornice line. The destruction at this point was perhaps as great as that in any part of the territory affected by the earthquake.

At Mills College, just outside of Oakland, there was a structure of concrete, a bell tower eighty feet high with four-inch walls of reinforced concrete. This was not damaged in any way.

Another reinforced concrete structure was the Cyclorama in Golden Gate Park, which demonstrated the futility of attempting to successfully provide against earthquake shocks where the foundation is bad and the materials poor. The walls of this structure rested on a foundation made by leveling off the top of Strawberry Hill; the aggregate of concrete consisted of a hard shale, which made a very inferior concrete, and a careful inspection of the ruined structure shows that little else could have been expected under the conditions. In San Francisco proper, in the fire zone, the behavior of concrete was equally satisfactory, and there are many cases where concrete successfully passed both the strength and fire tests. There were but two structures of rein-

forced concrete, namely, the Bekins Van and Storage building and the Academy of Sciences. The former was in process of erection and had reached the second story, while the latter was an old structure. The walls of each structure were of brick and were cracked extensively by the earthquake, while the concrete remained undamaged, both structures being completely burned out, but the concrete was not damaged in the slightest degree. The columns in the Academy of Science building were cast iron, filled with concrete, and in one instance where the cast iron expanded and failed by cracking the concrete core remained uninjured.

Cinder concrete was most generally used for floor construction and behaved in an entirely satisfactory manner.

The failure of plaster (gypsum) and terra cotta to protect steel against fire was most general. The utter inefficiency of commercial terra cotta was everywhere apparent, while cement or concrete, properly applied, on the other hand, was entirely adequate for the purpose. I believe that a terra cotta tile can be made which, when properly applied, will adequately protect steel structures, but it is not so made commercially to-day.

I think, to the unbiased observer, concrete gave sufficient evidence of its ability to resist both earthquake and fire; its rigidity making it an admirable earthquake material, while its extremely low rate of conductivity for heat makes it a fire resistant of high order. The San Francisco earthquake, with the resultant conflagration, will be of inestimable value to the future constructor in furnishing reliable evidence of the value of the various classes of material, and the record is but another testimonial of the admirable properties of cement.

Its strength and durability, its cheapness in comparison with other materials of construction places it in a position in which its future is absolutely secure. We are not fully conversant with its properties, its strong and weak points, and it behooves us to go slow and not be precipitate in its indiscriminate and reckless use.

The bold design in reinforced concrete, when taken in connection with the lack of a definite knowledge of some of the factors required in such design, is venturesome to say the least.

Nor is this venturesome spirit confined to reinforced concrete alone. Plain concrete is used under conditions requiring reinforcement, and building blocks are used for purposes for which they are utterly unsuited and under conditions which are dangerous.

Wherever failures occur, it is generally cement that has to bear the blame. And on this material all the sins of omission or commission are heaped, and yet it should be noted that it is extremely rare that failures are traceable to the quality of the cement used.

Where an unbiased examination is made, the failure is generally found to be due to bad workmanship, improper design, insufficient strength and a too early removal of the forms for the construction or all of these, and many failures occur from improper material, insufficient mixing, improper consistency for effective tamping. In these days of machine mixing too little attention is given to the rigorous inspection of the process. As an illustration of this point I would state that on a large piece of work the system used in the mixing of the concrete was such that the sand was thrown in by one man, the crushed stone by another and the cement by a third, the latter being called away from his post, failed to perform his part, but during the interval the sand and stone went in with rhythmic precision. It is obvious what the effect of these batches of concrete would be and how fatally they would affect the strength of an important part of the structure. In another case which I have in mind the cement, sand and stone were fed automatically from hoppers so adjusted as to give the requisite proportion. At the time of this inspection the cement hopper had choked, but the sand and stone were flowing on, and the operator, who was totally unaware of the fact, remarked, when his attention was called to it, that he thought the concrete looked rather peculiar. Perhaps the greatest source of failure is the strength of the forms; too little attention is given to the design of these forms, and they are often made entirely too light for even normal conditions, and where a temporary load in excess of that for which the structure was designed comes upon it the structure is either dangerously strained or collapses. I have in mind cases where excessive

quantities of cement have been stored on the green concrete structure and in one instance producing a collapse of the floor panel. Concrete of improper quality is often used, and I recently saw in New York cinder concrete consisting of one part of cement and five parts of cinders going into a reinforced concrete structure. Again, the length of time which should elapse before the centering is removed has a marked bearing on the question of failures. The time required for concrete to harden sufficiently to permit the removal of the forms is naturally a variable one, depending on the design, the weather condition, and the strength of the concrete. A concrete with a small percentage of cement will require a longer time to acquire the requisite strength than a richer mixture; it will also take concrete longer to harden in cold than in warm weather, and a beam of long span must be stronger than the one of short span before the form can be removed.

Another source of failure is the lack of attention to details, especially as regards connections in the erection of a structure. The structure may be properly designed with the requisite amount of steel, yet the structure may be fatally weakened by the character of the connections. A reinforced concrete structure should be practically a monolith—the tension members must be continuous in beams and columns.

It makes a material difference as to the length of the splice allowed in such columns or whether the splice in continuous beams is adequate.

I have in mind an instance which came to my notice of an enterprising laborer who, observing the rod in a column projecting out of the concrete in the column of a several story building, seized a sledge hammer and drove the bar down flush with the surface of the concrete.

The remedy for all this is inspection, most careful inspection.

No more unstable material is in use to-day than cement. From the moment it is reduced to an inpalpable powder it undergoes changes which seriously affect its quality. Unlike steel, wood, or similar materials, it does not stay tested and its quality must be ascertained before use.

When we consider the way in which so delicate a material

is handled by unskilled laborers it is not surprising that failures should occur.

A steel beam or channel is fabricated at the mill and undergoes during the process of manufacture a most rigid and careful inspection, and in the erection again undergoes careful inspection. On the other hand, a concrete structure is fabricated on the site and is subject to little or, at the best, indifferent inspection and the unintelligent laborer contributes to the abuse.

The same careful and rigid inspection should be given the erection of a concrete structure as a steel structure receives, and until this done we may expect failures.

Amid the ignorance and wonder that attends the use of a new material the charlatan practices his art unchecked, new forms of patented construction are constantly springing into existence, many absolutely devoid of merit and the public are being proportionately humbugged and deceived.

Plans and specifications are generally prepared by the contractor and for every skilled, competent contractor there are many who are incompetent who do not hesitate to skin the work in order that they may finish it without loss of profit, having taken it at a figure entirely too low to admit of proper workmanship with first-class materials.

Such practices are wholly unnecessary, for first-class legitimate construction can successfully compete with other forms of construction, and there are many reliable concerns capable of executing such work.

Owners, architects and engineers are criminally responsible where they award work to irresponsible contractors, lacking in the requisite experience and knowledge for safe construction or who permit structures to be erected under the direction of competent persons who do not give the work their personal supervision.

Where the charlatan reaps his greatest harvest is through the medium of the beguiling literature giving strength values based on tests primarily made for the purpose of developing and exploiting the strongest features of the system for which he holds the patent.

Many concerns rush in with inadequate experience, acquiring this at the expense of their clients.

The present condition of the art of concrete or reinforced concrete construction is not unlike the condition of the iron business in its early history not so many years ago.

The knowledge relating to the construction of highway bridges was at that time largely vested in the contractor, and it was the practice for the contractor to submit bids for bridges based on his own plans and specifications, and the number of failures of highway bridges was directly attributable to this fact, and it finally drove the constructor into making his own designs and specifications, with the result that the contractor bid much more closely and intelligently on a definite plan and specifications, and failures in such structures became a thing of the past.

This experience, I believe, will be repeated in the case of structures of cement. In the meanwhile until our knowledge of the properties of concrete is more fully established, its strong and weak points more thoroughly understood; it behooves us to go slow and be more conservative and careful in its use. The failures which occur from time to time unquestionably hinder the development of the industry in that they cast doubt upon a comparatively new material and make builders cautious in its use.

I would repeat that we should recognize the weak points of cement and further see to it that its good points are not abused.

The comparatively few failures in concrete structures are allowed to overshadow the great number of excellent examples of well designed constructions of this class. And it should be noted that what failures there are occur during the process of erection and are almost invariably due to a too early removal of the forms or bad workmanship.

The failure of a structure of concrete by reason of improper design, bad workmanship or poor materials is no more an argument against the value of concrete for construction purposes than is the failure of a structure of steel under similar conditions an argument against the use of steel for structural purposes.

We may expect failures as long as incompetent men will undertake to design structures in concrete and unskilled and ignorant persons will attempt to "skin" the work for the purpose of increasing their profits; and it will only be the continual loss

of life that results from these failures that will bring the authorities to such a realization of their responsibilities as will result in laws which will properly safeguard the public.

It will only be by determined action that the present abuses can be curbed and the fair name of concrete preserved.

It is the duty of every user of this material, of every friend to join most heartily in the cause. Let each of us put our shoulder to the wheel, thereby controlling this rapid movement in the application of cement to constructive use lest it get away from us and go on to destruction. We should not be afraid to state the truth, even though it hurts; we should by all means be honest, and not hold malice toward those who frankly call our attention to the few weaknesses in the most magnificent building material at the command of the constructor.

REPORT OF COMMITTEE ON SIDEWALKS, STREETS AND FLOORS.

By George L. Stanley, *Chairman*.

In preparing specifications for sidewalks for adoption by this association it has been the aim of your committee to only bring before you such specifications as when followed will result in good and serviceable walks.

In the United States there is such diversity of materials for the principal aggregates that it would seem almost impossible to specify the amount of cement and have a uniform strength. If it was only choosing a suitable brand of cement, there would be but little difficulty, as most of our cement mills make only high-grade cement.

Both sand and gravel are often of a poor quality, and it is often difficult to get the sizes of gravel suitable for sidewalk concrete. Gravel, of which the average size is one-fourth of an inch, requires at least one-fourth more cement than when the sizes are an average of one-half of an inch.

The committee has recognized this fact, and given the amount of cement for the minimum size as the safe amount to be used in all sizes.

As to the amount of water to be used there is a difference of opinion among cement users, but for two-coat work, the amount of water used should be such as will insure a solid mass when the walk is finished.

A perfect union of both top and bottom coats can only be accomplished by tamping the two coats together, and tamping can only be done successfully when just water enough is used to allow the air in both bottom and top coats to escape as the walk is tamped. Some claim that it is too slow work to stop and tamp.

The experience of the chairman of your committee has been that, everything else equal, as many square feet can be laid in

a day by using the amount of water specified in the specifications than by using more. The delay of waiting for the water to soak out or dry out, more than offsets the advantage of quick spreading and striking off the top coat.

It has been the lot of your chairman to relay, take up, and replace many walks. Tamped walks, where good, clean, sharp sand and gravel were used have been found to relay and not show any defects, even after the walk had been in use seventeen years, but where an excess of water has been used the walks have been broken by frost, and often the top coat has separated from the bottom coat. The apparent reason seemed to be that the top was not united to the bottom coat.

Your committee has inserted specifications for the position of shade trees, knowing that in many of our growing villages and cities it would be for the good of sidewalks to pay some attention to the liability of the troublesome root displacing the sidewalks.

The thickness has been given for the minimum amount of concrete to be used, so as to insure good, serviceable walks.

The whole matter of adopting, or referring the specifications to a special committee is left to the convention to discuss and act its pleasure.

SPECIFICATIONS FOR SIDEWALKS

Foundations.—The ground base should be made as solid and permanent as possible. Where excavations or fills are made, all wood or other materials which will decompose should be removed and replaced with earth or other filling like the rest of the foundation.

Fills of clay or other material which will settle after heavy rains or deep freezing should be tamped solid in layers not more than 6 inches in thickness, so as to insure a solid embankment which will remain firm after the walk is laid.

Embankments should not be less than two and a half feet wider than the walk which is to be built. When porous material, such as coal ashes, granulated slag or gravel is used, underdrains of agricultural tile should be laid to the curb drains or gutters so

as to prevent water accumulating and freezing under the walk and breaking the blocks.

The position of shade trees should not be less than four feet from the walk. Carolina poplar, elm or other shade trees whose roots run near the surface of the ground should not be less than ten feet from the walk.

Lines and grades should be given by an engineer; the stakes to be not over twenty-five feet apart and far enough from the walk line so that an inspector may see that the walk is laid to line and grade.

The mold strips should be firmly blocked under the ends and the center of the strips and carefully straight-edged, care being taken that the strips are parallel with the engineer's line the height of the grade stakes. The walks should be laid with a grade of one-fourth of an inch to the foot towards the gutter.

The thickness of the walk should be determined by the location, the amount of travel and danger of being broken by heavy bodies falling on it, or frost.

Business front walks should not be less than four inches thick, and can be six inches thick with profit. The top coat of business walks should not be less than one and one-fourth inches thick.

In residence districts the top coat should not be less than one inch wearing thickness, and the thickness for different widths of walks should be as follows:

6 feet wide the minimum thickness at the center should be 4½ inches, at the edges 4 inches.

5 feet wide the minimum thickness at the center should be 3¾ inches, at the edges 3½ inches.

4½ feet wide the minimum thickness at the center should be 3¾ inches, at the edges 3½ inches.

4 feet wide the minimum thickness at the center should be 3½ inches, at the edges 3 inches.

For all other widths the minimum thickness at the center should be 3½ inches, at the edges 3 inches.

Size of blocks may be determined by the width and thickness of the walk. Business front walks should contain not over:

12 square feet when the walk is	4	inches thick
16 square feet when the walk is	5	inches thick
20 square feet when the walk is	5½	inches thick
25 square feet when the walk is	6	inches thick

In residence districts where the walks are:

6 feet wide 5 inches thick at the center the blocks can be.....	6	feet long
6 feet wide 4½ inches thick at the center the blocks can be...	5	feet long
5 feet wide 4½ inches thick at the center the blocks can be...	5	feet long
5 feet wide 4 inches thick at the center the blocks can be.....	5	feet long
4½ feet wide 4 inches thick at the center the blocks can be...	4½	feet long
4 feet wide 4 inches thick at the center the blocks can be.....	4	feet long
4 feet wide 3½ inches thick at the center the blocks can be...	4	feet long
Other widths less than the above 4 inches thick at the center the blocks can be	4	feet long
Other widths 3½ inches thick at the center the block can be.	3½	feet long

BOTTOM COAT, GRAVEL. The largest size not to be over 1 inch and all under ⅛ inch to be considered sand. Proportions to be one part high-grade Portland cement to four parts clean, hard gravel, and sand enough to fill the voids, which makes the proportions, for most gravel after being filled with sand, one part cement to five of the whole aggregate sand and gravel.

BOTTOM COAT, CRUSHED STONE. The size of broken stone should not be larger than ¾ inch, and vary in size to ¼ inch, and free from fine screenings, dust or soft stone. Proportions to be one part high-grade Portland cement, two parts clean and sharp sand and four parts broken stone, or one cement to four of stone, and sand enough to fill the voids.

Mixing of both gravel and broken stone should be done by placing it in the mixing box or on the platform first, then spread the sand evenly over the stone and in like manner the cement over the sand. Then cut through from top to bottom in thin slices, which will insure an even mix. Then turn with hoe or shovel twice before adding water, which should be done with a sprinkler and hoed over as sprinkled. The batch should

be turned at least once after the water is applied. The amount of water used in the bottom coat should be only enough to make it, when firmly tamped, solid and not quakey.

TOP COAT PROPORTIONS. Three parts high-grade Portland cement and five parts clean, sharp sand, mixed dry and screened through a No. 4 sieve. In the top coat the amount of water used should be just enough so that the surface of the walk can be tamped, struck off, floated and finished within 20 minutes after it is spread on the bottom coat, and when finished it should be solid and not quakey. An edger not less than 1 inch radius should be used on the outer edges of the walk.

Separation of the blocks should be done with a spud not over 6 inches wide and 1/4 of an inch thick, and to insure complete separation the groove should cut through into the ground base. Fill the groove with dry sand before the top coat is spread, and the top coat should be cut through to the sand after floating and troweling and a jointer run in the groove, then again draw a trowel through the groove so as to insure a complete separation of the blocks.

The protection of newly finished walks from storms can be accomplished by covering with roofing paper or canvas. Canvas should never be laid on the walk, but stretched over on a slant so as to run the water off.

Grading after the walks are ready for use should be on the curb side of the walk 1 1/2 inches lower than the walk and not less than 1/4 inch to the foot fall towards the curb or gutters. On the property side of the walk, the ground should be graded back at least 2 feet and not lower than the walk which will insure the frost throwing the walk alike on both sides.

DISCUSSION.

PRESIDENT RICHARD L. HUMPHREY.—Gentlemen, the subject is now open for discussion.

MR. JOHN EASLEY.—Mr. Stanley, have you ever used the Joplin flint, from the Missouri mining district, instead of gravel?

MR. STANLEY.—I know nothing about this, but if the material is hard and flinty and will not be affected by the frost or by exposure to the air, it will be good material for the bottom coat.

MR. W. F. WISELOGEL.—Mr. Stanley has not pointed out the effect of contraction or expansion of the concrete in a cement sidewalk. In some cases it has been sufficient to raise the pavement from two to four inches. We have found that it is well to leave a joint of not less than half an inch every 66 feet, for a city lot, even though partial provision for expansion is made by cutting through with a spud and dropping in sand. In some places sand is, however, not easily procured, and takes time to place. I would like to ask Mr. Stanley what he thinks or knows or believes about the expansion or contraction of cement.

MR. STANLEY.—I have had just such an experience as has been spoken of, but where I have been particular to cut through to the ground base and then cut through on the side, right through all around, I have had no walks buckle. It gives a chance for the expansion that is necessary. A walk is especially apt to buckle if it is going up over a little knoll.

MR. C. W. CADWELL.—I have seen the buckling to which Mr. Wiselogel referred, but in about fifteen years of experience I do not think I have had that happen more than six or eight times. Why should we go to all that expense for a block breaking perhaps once in five years. I have seen that occur when a walk was down twelve or fourteen years. If no joint is left between the pavement and the curbing the expansion of the curbing will throw the curbing out of line from a quarter of an inch to an inch or more. That is where the expansion is. In building against a curbing my experience is that one inch is not too

much ground to leave between the back of the curbing and your walk. I also try to run back in order to give it half an inch or three-quarters of an inch next to the curbing and back ten feet another half inch. Three years ago I built nearly $80,000 worth of sidewalks, and I do not know of but one break I have had to repair, I suppose, fifteen or twenty places where the pavement extended to the curb, but the walks themselves were in perfect condition. In order to lessen the stress due to the expansion of the concrete, I cannot see why it should be necessary to go to the expense of providing expansion joints so often, or, if it is, if we can get at the principle or a scientific idea of the why and wherefore of it, perhaps we could regulate it a little better.

In regard to cutting walks to different squares and different thicknesses, we never cut a six-foot walk into less than six-foot squares, and we never build a walk on a residence street over four inches, and I know thousands of them are built less than three. I would like to hear a thorough discussion of the question of expansion, because this is a serious one to many, and if there are many cement makers in the room I would like to have them come and tell us why the cement expands so much. It is in the cement, since some cement expands vastly more than others. I know that in the old days when we used nothing but the very best Portland cement it was almost an unheard of thing for a block to rise and burst in that way. But it is not uncommon now. It may be because we get cement direct from the mill uncured. Surely the cement manufacturers can give us a little better idea of this expansion and the best way to treat it.

MR. ELI DEFNET.—How much of a footing is necessary on a clay soil to insure good walks?

MR. STANLEY.—Along the south shore of Lake Erie in places where we can get a good, firm, solid basis we have been laying the pavement directly on the ground with no other foundation, with just as much success as if we had used the porous foundation. Water is liable to accumulate in the porous foundation and the possibility of damage due to frost is much greater than it would be if the pavement were laid directly on the clay

itself. Where the frost goes from four to five feet below the ground the porous foundation must be very deep in order to ensure its success.

MR. W. J. GENTHNER.—Would it not be necessary to keep these expansion joints free from dirt or sand to have the benefit of them? Would it not have the same effect as if they were placed tight together?

MR. STANLEY.—Of course, that has an effect. Although you would naturally suppose expansion would be worse in summer, it is worse in winter. It buckles in the summer, but it is thrown in the winter by the frost when the water which gets in the open expansion joints freezes.

Mr. Cadwell spoke of curbs being thrown due to the expansion of the pavement. We have had that trouble in Ashtabula. This can be prevented by digging down below your pavement, say four or five or six inches, and putting the concrete in it and back say two feet, with a little expansion joint at the top of the pavement.

MR. W. F. WISELOGEL.—We have all had that experience, but we have come to another conclusion, and we have tried it with fair success. In place of leaving this expansion joint at the corner, if we can prevail upon the man building the curb, we drop an inch or an offset the thickness of the walk, and we extend the walk to the inner edge of the curb and then let it slide. We find that has prevented the breaking of the curb. Referring to the effect of dirt in the expansion joints, I scarcely think it will make the walk expand as a unit and thus cause buckling, for the dirt is much more elastic than the concrete of the pavement and will give way under pressure.

MR. SANFORD E. THOMPSON.—I feel that perhaps an engineer has no business to make suggestions to practical men who have been in the business of walk-laying for years, and yet I would say from the practical side of the question that in Boston and vicinity, where cement walks are used to a very great extent, this reaching is practically unknown. I have scarcely ever noticed the lifting of walks when they were properly laid. The method of construction followed in Boston and vicinity, in a general way, is to excavate the ground to a depth of about sixteen inches

below the finished surface of the walk and put in twelve inches of very coarse material. Cinders are used to a very great extent for this, so that the water can drain out through the cinders. Sometimes gravel is used, or broken brick. Anything, so long as it is porous—that is, full of void, so that the water can drain. The same plan is followed under the curbing. An extra depth of excavation is made; a solid course of concrete, about eight inches thick, I believe, is laid on top of this porous material, then the curb on top of this. It seems to me that it is possible that some of this expansion may be really due to water getting under the walk and freezing and throwing it out, especially if it occurs in winter. Good cement set in air will not expand. That, I think, is a well-proved point. If the cement is poor, contains free lime, it is possible that this might occur, but the real expansion in concrete occurs from temperature. That is the only expansion in good concrete. This might occur in walks when walks are laid in cold weather. Then if they are laid with tight joints, when the warm weather comes, it is possible that the expansion might throw these slabs. In the bottom of Jerome Park Reservoir, New York City, there is a very large area of concrete which resembles concrete walks in the general construction. In the center of this reservoir, when first laid, there was a trench left to drain out the reservoir when it was emptied, and this was concreted, forming a ditch in the center. Now, the expansion by the sun on the surface of say two or three hundred feet in width expanded the concrete so as to crack the ditch and throw it at that point—raised it about four inches, and threw it out about two inches. The amount of expansion was readily calculated from the temperature expansion of concrete. I merely speak of these points by way of suggestion as forming a possible explanation of the difficulty in certain cases.

MR. H. H. RICE.—There is a great similarity between the specifications of Boston, as referred to by Mr. Thompson, and those of St. Louis. When I read the St. Louis specifications, I was amazed at the depth of foundation required by that city for their sidewalks. They were not laid on top of the ground. They were laid with a two- or three-foot foundation and were of most excellent quality. If there is a gentleman from St. Louis present, I wish he would tell us how he obtains such good results.

MR. H. S. HIBBARD.—Mr. Thompson is correct in saying that we put in twelve inches of foundation in Boston. We do not see the necessity of making the walks any thicker in the center than on the edges, and we make the mixture pretty wet. We think that gives the best results. But if I could be sure that a dryer mixture would do the work, of course it would save time, and I would like to hear from others on that subject.

Speaking about prices, I should say a pavement costs 17 cents to 22 cents a square foot. We think 17 cents is a pretty cheap job, and 18 to 20 cents is a fair price per square foot for good granolithic sidewalks.

MR. R. SCHULTZ.—The city's specifications for sidewalks in St. Louis require eight inches cinder foundation and three and a half inches coarse mix, and one and a half inches top dressing. The coarse mix is supposed to consist of one part cement, three parts of fine and five parts of coarse material, and the finish is supposed to consist of one part cement and two parts sand. We use almost nothing but crushed granite in construction, and make the walks in the center just as strong as on the edges.

The prices range from 18 cents to 20 cents, that is, 18 cents for large jobs on big stretches and 20 cents in small jobs.

MR. BENNETT.—If there is no outlet for the drainage of the sub-base, will a porous foundation be of any value?

MR. R. SCHULTZ.—There is no outlet for the drainage. The pavement is dug out twelve inches deep; then we put in four inches of cinders and four inches of the sand. The water will stand in the cinder foundation. We have a clay soil in St. Louis which is almost impervious, the water remaining on it until it either runs off or is evaporated.

MR. ELI DEFNET.—When the water cannot get into the porous foundation, what is the use of the deep foundation?

MR. R. SCHULTZ.—In cold weather the clay ground will freeze and will crack; consequently the granitoid walk is liable to crack also. That is the reason we put cinder foundations under.

MR. F. M. HUNTER.—I thought Mr. Schultz might tell us how to obviate what is termed "the scaling of the top finish from

the concrete below." Furthermore, I notice that no one, in discussing the concrete sidewalk question, has taken into consideration the difference in soil and climate. In St. Joseph, Missouri, the soil is very dry and porous. A four-inch base of cinder properly put in is sufficient there in almost every case. But I realize that it would not, perhaps, do in Chicago, where the soil is different and the surface very level. Neither would it do in Boston, where they have much colder weather than we do. I would like to have the experience of those who know about those things to enlighten the convention.

MR. L. L. BINGHAM.—It seems to me that this matter of the sub-base, as it is called, or the drainage part of the sidewalk, is one of great importance, because if it is necessary it should be used. If it is not necessary there is a whole lot of money being wasted in making it. Some of the previous speakers have brought out the fact that the deep, porous sub-base is not always used and is apparently not always to ensure success. I scarcely think it is true that drainage is more necessary in the north than in the south. At the convention of the Northwestern Association, at Minneapolis, Minn., the past two years, we have had that matter discussed by men who do not use this drainage base and who have had several years' experience in the district which is a considerable distance to the northwest of that referred to by the speakers on this subject. I would like to ask Mr. Hibbard whether he has had experience in laying walks without the drainage base. The surface formation of Iowa varies considerably. We have in some places considerable sand and gravel; in others the rock comes to the surface or almost to the surface. By using a deep foundation this irregularity in bed is done away with and a uniform foundation secured. In addition, the use of this porous material ensures much better drainage than could otherwise be secured.

MR. TRACY.—This matter of drainage interests me more than any other part about the cement walk problem, as I live in a country in which the soil is a tough, sticky, impervious clay. I find that if we dig down twelve inches, as our specifications require, and fill with cinders, the water is drained under the sidewalk instead of away from it. If we make no provision for

the drainage of the water away from the foundation it freezes and bursts the walk. I find that in localities having a porous soil the water drains from the foundation into the soil, and the walk consequently does not burst as it would if there were a clay soil. In other localities we cannot do that. For instance, we build a sidewalk in front of one of two properties, one of which has a brick sidewalk that has never been dug up. We dig down twelve inches for our foundation and have no way of getting the water out of there unless we lay a tile from there to a manhole or something like that. Unless we do this we are not draining from under the sidewalk, we are draining in under it, and will have a broken sidewalk as soon as this water freezes. In my judgment the great expense of digging for a deep foundation is all uncalled for, and I believe that the walk will be a better walk if we will dig out about four inches and see that the water gets away. There will be a better chance for the water to get away if the curb may be six, seven or eight inches, and it makes a better job.

MR. STANLEY.—I suppose we all agree fairly well on the drainage question. If the ground is good and solid I don't care to have even a four-inch foundation. It seems to me that one of the secrets of success in sidewalk construction is proper grading as soon as the walk is opened. When the frost freezes the ground so it raises the walk and the ground together, there is but little or no danger from breaking those blocks. But if the ground is not graded properly, so that the water passes off just before the freezing, then there will be trouble. If the ground is higher on the property side frost will throw the walk badly. I laid a walk along a bank that was perhaps two feet higher than where I laid the walk. There was a slope of thirty degrees right down to the walk. The man who did this work, although told to grade the bank back from the walk, failed to do so. The walk was thrown by the frost on the side towards the street fully six inches higher than on the side toward the lot.

CEMENT SIDEWALK PAVING.

By Albert Moyer, Assoc. Am. Soc. C. E.

Cement sidewalk paving is a manufacturing industry whereby cement stone slabs are framed in place on the job. Paving of this description has various uses. Its principal use is a permanent path for pedestrians. Among the other uses are driveways for vehicles, a floor wearing surface for buildings, platforms in the stations of transportation lines, wharf coverings, cellar floors, curb and gutters The principal objects to be accomplished in manufacturing these cement stone slabs for the above named purposes are permanency, durability and neatness.

Its Permanency.—To accomplish permanency it is necessary that these slabs remain hard, tough and in the original position for the average life of good construction work. To accomplish this object, correct methods of manufacture must be employed which will avoid settlement cracks, upheaval by frost and roots of trees, crumbling due to work having been laid in freezing weather, contraction cracks, expansion cracks, separation of top from base and disintegration.

Settlement Cracks.—To avoid settlement cracks it is necessary to thoroughly ram the ground after excavating for foundation. After drainage foundation has been put in place this should be thoroughly and evenly tamped so as to avoid uneven strain. The thickness of the slab should be governed by the factor of safety necessary to provide for the weight that is likely to be placed on any one slab. It is estimated that a number of persons can be so crowded together as to cause a weight of from 100 to 150 pounds per square foot. As the strength of the slab is not always governed by its thickness, it will be necessary to properly proportion the aggregates so that maximum density results.

Upheaval by Frost.—To avoid upheaval by frost, a proper drainage foundation must be provided, such foundation to be carried to a sufficient depth to get below the average frost line as

may occur in the various localities; a drainage foundation is of use only in event that it thoroughly drains. Such a foundation is often placed so that it not only fails to accomplish the purpose for which it was intended, but practically defeats that object by causing an accumulation of water which in freezing upheaves the pavement. A drainage foundation should have an outlet which has a fall of about one-fourth inch or over to the foot. If there is no natural outlet for such drainage, blind drain leaders should be provided at points along the walk where they are necessary. These leaders should be formed of similar material as the drain itself, with possibly the addition of a porous drain tile leading into holes filled with cinders or crushed stone, which will allow the surrounding earth to absorb the accumulated water.

Upheaval by Tree Roots.—This can very easily be avoided by cutting out any roots which will run under the pavement higher than a depth of eighteen inches to two feet.

Contraction Cracks.—Portland cement concrete expands and contracts in practically the same ratio as steel; it is therefore necessary to cut joints which will allow for this expansion or contraction. The concrete must be cut entirely through with a cleaver, or other instrument, from one-eighth to one-fourth inch wide, the blocks thus formed to not exceed six feet square. I am fully aware that very excellent work has been done, the blocks being as large as from 12 to 14 feet; that good results were obtained with such large slabs is due more to favorable circumstances than to correct method. By figuring the expansion and contraction per degree between the heat of summer and the cold of winter, it will be found that we are only within the region of safety when the slabs do not exceed six feet, with an eighth-inch joint between each slab.

Expansion Cracks.—Expansion cracks are not due so much to the expansion of the cement stone slabs as to the expansion of other material bearing against these slabs; it is therefore advisable to cut the concrete away from the manholes, iron posts, etc., leaving about the same space in the joints as between the slabs themselves. This space may be readily waterproofed by using felt paper painted with a good waterproof paint.

Separation of Top From Base.—In the past it has been a very common practice to allow the base to set hard before laying the top coat; it is unnecessary at the present date to dwell on this subject; we all know that it is utterly wrong. There are, however, other causes which prevent the top coat from adhering permanently to the base, the principal cause being carelessness in allowing men to walk over the base carrying with them dust and dirt, also failure to protect the base, allowing the surface of the base to be exposed to the rays of the sun and thus dry the surface prematurely, at the same time allowing dust and dirt to blow over the surface, coating the concrete so that the top when placed fails to adhere permanently. It is also absolutely necessary that the top be cut directly over the cuts in the base; otherwise the top coat will crack along the line of least resistance. To obtain good and permanent results whereby the top coat becomes a permanent part of the base, one brand of cement should be used in the top and in the base; the difference in time of setting, the characteristics of one brand being different from another will often cause a separation of top from base.

Disintegration.—The principal cause of disintegration is insufficient mixing, drying out before ultimate crystallization of cement and bad material used. Start right and good results naturally follow. To avoid disintegration, material should be carefully selected. This selected material must be thoroughly incorporated and mixed in a plastic mass with sufficient water to bring about ultimate crystallization of the cement. Being thus mixed, it should be immediately placed, thoroughly and evenly tamped and then protected from drying out before final setting. Cement needs water, not only when mixed but after having been placed and tamped, and it requires water until ultimate crystallization has taken place. If any portion of the concrete is robbed of the amount of water necessary to bring about this result, the concrete is weakened to that extent.

Selection of Material.—It is important that the best material be used in the manufacture of Portland cement sidewalks. Poor material makes poor walks and costs just about as much money. For a very strong concrete a hard stone without any surface scale is absolutely necessary. A rich mortar will not entirely counterbalance a deficiency in the strength of the stone. For a

medium strong concrete, the hardest stone need not be insisted upon, but rather one to which the mortar will best adhere, such as some of the limestones. Stone broken in cubical form is far better than one breaking in flat layers, such as shale or slate, it being almost impossible to ram or tamp such stone into such dense or compact a mass as that breaking in cubical fracture. The trend of the times is toward small stone. The writer advocates a concrete made of stone, all of which will pass through an inch mesh; and, better still, all of which will pass through a three-quarter-inch mesh, and so graded in size that as far as possible the voids of each progressive volume are filled with the largest size particles that will fit them, graded from three-fourths inch down to fine dust. Thus a minimum of cement will give a stronger concrete in compression than could be obtained with a larger percentage of cement using the same quantity of sand and stone, but not so well graded in size. A stronger concrete can be made without the use of sand. Instead of sand, use screenings or quarry tailings made from only the hardest and toughest stone. These screenings are usually graded in size, each particle furnishes a better anchorage for the cement, greater density results, better adhesion and a stronger concrete than can be obtained by even the best of sands. Gravel is often superior to broken stone and sand, being generally found graded from coarse to fine; the roundness of the pebbles lends aid to compactness. Keep in mind that density is the object to be obtained. Maximum density is maximum strength under compression. Gravel is not likely to bridge and leave holes in the concrete. The coarse pebbles are harder, stronger and less liable to fracture. In discussing gravel *versus* broken stone, I am considering a concrete made of gravel and sand *versus* concrete made of crushed stone and sand, and in this discussion quartz pebbles, or rather very hard pebbles, are referred to. Sandstone pebbles are not considered as good as the better grades of crushed stone. The usual argument against gravel is that the mortar is not supposed to adhere as well to the surface as to that of fresh-broken stone. This is one of the theories which is practically due to the appearance of the surface to the eye or touch; the adhesion of mortar to limestone of a smooth surface may be far greater than to standstone or rougher materials. If roughness was the only

requirement for adhesion, it would seem impossible to cement together two pieces of glass, and from the standpoint of durability, gravel must be superior to stone for the reason that by the law of the survival of the fittest and by process of elimination, nature has supplied us with the most durable. In selecting sand, the value of sand for concrete mortar depends largely on its coarseness and graduation in size of the grains. Avoid the use of fine sand. It makes a concrete which resembles pumice or punk. The reasons for this are well known. This is a subject which would require too long a time to discuss in this paper. The sharpness of the grain of sand has little to do with its value. It has commonly been supposed that sand should be sharp. The writer is rather in favor of a very coarse, round-grained sand. Compactness is what is desired, and round grain will give greater density to the mortar than sharp grain, and cement will cling to the surface of round grain as well as sharp, the character of the surface being identical. Sharp sand as an indication of value is only useful in that it denotes a silicious sand. The best sand is that which when mixed with cement and water in the required proportions by weight produces the least volume of mortar. The method of determining the best sands to use for the purposes of economy is another subject which is too lengthy to discuss in this paper.

In selecting Portland cement, it is best to specify the requirements of the "Standard Specifications" as adopted by the American Society for Testing Materials, and select for purchase that brand which is produced by manufacturers of experience and reputation, as ascertained from a number of well-known engineers, their experience extending over a period of at least five years. The selection of Portland cement is largely that of reputation, the manufacturer having made a reputation by producing a uniformly excellent article, cannot afford to sacrifice that reputation; a brand of long and good reputation having been purchased, the specifications and tests of the American Society for Testing Materials can be held as a check against errors or mistakes in manufacture. This method of selecting Portland cement always gives the user the best material obtainable at the fairest price—not the lowest price—making it to the advantage of the

manufacturer to produce for the user's interest, also offering an incentive to the manufacturer to produce the best product at all times, making improvements as science advances.

Mixing.—Having selected the best materials obtainable, by far the most important operation is that of mixing. The methods employed in mixing by hand as well as by machinery depend largely upon the character of the aggregate used. It is now being almost universally recognized that the small aggregates make the densest, strongest and best concrete. As a sample, in mixing a concrete made of three-fourths-inch hard limestone or traprock and good coarse sand, the cement and sand should be dry mixed, the best method is by use of shovels and a garden rake, each shovelful as turned should be thoroughly raked; dry three-fourths-inch stone is then added, and the process repeated; the mass should then be formed into a crater, a sufficient amount of water added, then turned with a shovel and raked as before. By this method it will be found that a more perfect incorporation of all the aggregates results than if the mass had not been raked, but had been turned another time with the shovels; the raking takes the place of one turning, but does it better. A perfectly mixed concrete results if the shoveling and raking is properly performed. Another method is, wet the mortar before the stone is added, proceed as before. I, however, have found that if quarry screenings or tailings are used for the mortar it is better to mix all the aggregate dry; that is, first the cement and screenings; then add the three-fourths-inch stone and mix dry; then add water necessary to bring the whole mass to the desired consistency, raking during each stage of the process as previously described; this for the reason that if the stone is added to a wet-mixed mortar the mortar will work up into balls and lumps, which are hard to break up, and which causes an uneven concrete; too much mortar in one place and too little in another. This same principle can be carried out in machine mixing for the smaller aggregates. Machine mixing should be accomplished much the same as it is in Germany, the mortar mixed dry, then the stone added, then the whole mass mixed dry; this entire mass is then run into another mixer and there mixed wet. This result can be fairly well accomplished by using

a mixer which has knives and rakes, which does the same thing as turning and raking in the hand-mixed process. Understand, I am not advocating this method only for concrete composed of the smaller aggregates.

Placing and Tamping.—The concrete should not be made so wet that it will quake under the tamping iron, unless steel strips are used for the joints or laid in alternate blocks; it should be sufficiently wet, however, so that some moisture arises to the surface under the tamping. The proportion of water necessary will vary according to the climatic and other surrounding conditions. The proper consistency can only be judged by the eye on the mixing board; no accurate specifications can possibly bring about uniform and desirable results. This is a matter which necessarily has to be left to experience. The tamping should be vigorous and uniform.

Drying Out.—One of the causes of bad workmanship is due to the concrete either in the top or the base having prematurely dried. This is avoided by keeping the concrete covered to protect it from the rays of the sun. If the concrete is anywhere near boilers or steam pipes; see to it that the concrete is wet continuously for from twenty-four to thirty-six hours; after this period sprinkle two or three times a day for a couple of weeks, or such length of additional time as economy will permit. Sidewalk paving slabs are acted on from both sides, and being comparatively thin are more sensitive than mass concrete, therefore need greater protection. The writer has seen instances where workmanship as far as selection of materials, mixing, placing and tamping were thorough and excellent, but, nevertheless, bad results were obtained. This was particularly true of a pavement laid over waterproofing. The atmosphere absorbed the moisture from the top and the top absorbed the moisture from the base. The base had nothing wet under it from which to get water, could not supply sufficient moisture to the top to offset the action of the dry air, the result was a top of chalky consistency. Had the foundation been made very wet and the top covered with wet sand no such results would have been produced.

Durability.—Durability relates principally to the wearing surface; there is no reason why a cement slab should not wear

longer than the ordinary natural stones; for in forming these slabs we have the advantage of selecting the toughest and strongest stones. Cement itself is tougher and stronger than most of the products of nature. The texture of the surface has a good deal to do with efficiency. A scum or skin of neat cement on the surface soon wears through, causing an ugly and blotchy pavement. There is no reason why a slab of cement stone cannot be manufactured which would wear for a hundred or more years; it might wear down to the extent of half an inch, or an inch or more, and still preserve the same texture. This is perfectly feasible by making a slab of one piece, no top coat whatever, an even, smooth top, carefully jointed, composed of small selected aggregates and in proportions which result in maximum density. I have seen one or two pavements of this character, notably the one around the Hotel Astor, New York, which is in nine-inch slabs, entirely around the building, expansion joints cut at regular intervals and so arranged as to form an architectural design. The concrete was composed of three-fourth-inch traprock and sand. The surface was floated off and smoothed down with a trowel; it was not troweled to such an extent as to bring any neat cement to the surface. This pavement will wear for two hundred years or more, and as it wears down the same texture is preserved. The usual troweled surface is slippery, it does not wear, is subject to all manner of diseases, such as hair-cracks, crazing, peeling, etc., and is only beautiful before the disease sets in. A monolithic slab leveled off and smoothed to an even surface in which flint or quartz pebbles show through, such as some of our granolithic sidewalks, can be thoroughly tamped and then floated so that the above desirable results are economically obtained. Another method is to use three-fourth-inch hard stone, quarry screenings or sand, making one slab at one time straight edge off, tamp uniformly, smooth down to an even surface with float and trowel, cut joints, carefully mark joints with a good jointer, round the edges, and after final set is reached, but before the surface has begun to dry, scrub with a steel brush such as is used in cleaning boilers; play a hose on the surface just ahead of the brush and scrub the surface vigorously. This removes the neat cement from the exposed sur-

faces of all the aggregates, does not disturb the aggregates, and gives a most beautiful, natural and genuine finish, similar to natural granite, you therefore have a pavement which is honest and genuine clear through, and is obviously so.

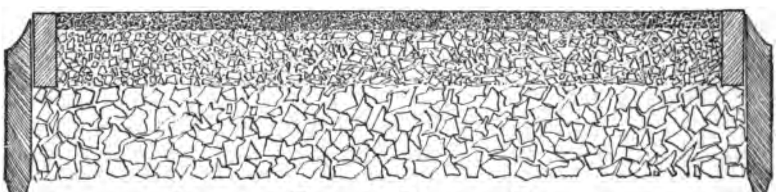
Neatness.—Neatness is obtained by the texture produced as described above, by carefully marking the joints and rounding the edges. Be careful not to use too much water so that an excess of water rises to the top, carrying with it particles of neat cement. This causes hair-cracks, crazing, streaks and efflorescence. Another disease is occasioned by an accumulation of water in any one or more places which will cause what has been commonly known as water-cracks, which are not open cracks, but surface cracks which look like dark blotches. In discussing this subject of neatness, observation would indicate that the thought uppermost in the mind of most sidewalk paving contractors has been that of forming an artificial top of veneer over the rougher concrete. Do not use lampblack, it is the worst form of poor imitation. Sidewalk paving construction, like all other forms of engineering, is only permanently and lastingly good if honest and genuine. I will sum up these suggestions by endeavoring to frame a set of specifications, leaving out as much detail as possible, so that they may possibly be standardized, useful and, I trust, universal.

CEMENT SIDEWALK SPECIFICATIONS.

Sidewalks in cold climates where frost occurs, should consist of a foundation of coarse cinder, broken stone, brick bats, or other porous material, extending below frost line, the concrete to be laid on this foundation. Do not lay concrete in freezing weather.

Drainage Foundation.—Excavate to a sufficient depth so as to provide for perfect drainage, ram and tamp the ground thoroughly and evenly, fill in with clean cinders, broken stone, or brick bats, to within ——— inches of top of the established grade of the pavement (a sufficient number of inches to provide for the thickness of slab necessary to give sufficient strength for the character of the work it is to perform) ; tamp this drainage

foundation well and evenly, thoroughly wet the cinders, stone or broken brick, place in position wooden forms in a manner necessary to accurately outline the top and external edges of the walk, the top of the form being located so as to coincide with the established grade of the walk. As an additional precaution, and where necessary to accomplish the purposes of drainage, side drains should be placed every ten or twelve feet, having a fall of not less than one-fourth inch to the foot, leading to some point forming an outlet for water which may accumulate.



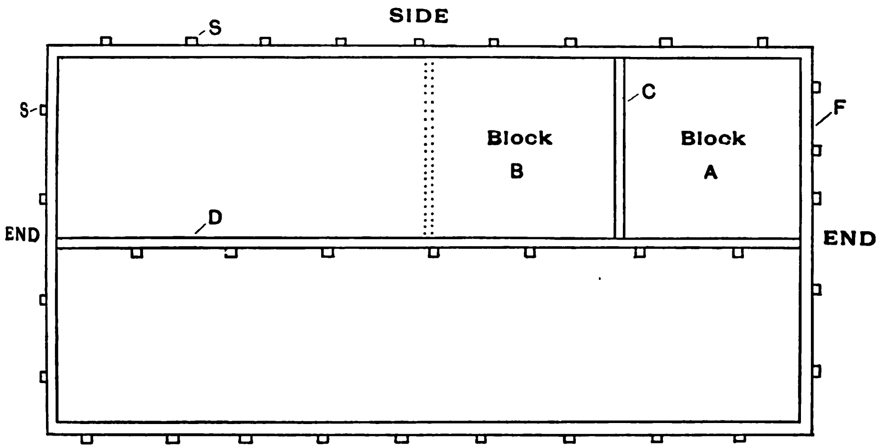
SECTION CEMENT SIDEWALK PAVEMENT

This outlet should be below the frost line and may be accomplished by a hole filled with cinders, stone, or brick bats.

Concrete Base.—For a concrete base, spread —— inches, number necessary to provide for the thickness of slab which will come to within one inch of the top of the established grade; this concrete to be composed of one part Portland cement and two and a half parts sand or quarry screenings, all passing one-fourth inch mesh, and five parts broken stone or gravel, all passing one-inch mesh.

These specifications may be regulated if proportions can be obtained which will allow of a larger proportion of broken stone, at the same time giving maximum density. Tamp the concrete to an even thickness, cut same into uniform squares of not over six feet square, using a steel cleaver of not less than one-eighth inch and not over one-fourth inch in diameter. Fill the joints thus formed with dry sand so that there is no possibility of the square blocks adhering together. Mark on the wooden forms the exact locations of these cuts. After each batch of concrete is laid as required, it shall be immediately covered with a top coat, or wearing surface, no dirt or dust having been allowed to accumulate on the base and the surface of the base to be wet or moist.

Any portion of the foundation which has been left long enough to have the appearance of setting or hardening shall be taken up and relaid before the top coat is put on. Another method of separating the blocks is as follows:



C—Wooden strips 2 x 3-inch lumber (movable).
D—Long wooden strips 2 x 3-inch lumber (movable).
F—Wooden frames 2 x 4-inch lumber, top of which coincides with established grade of walk.
S—Stakes for holding frame in position.

Place a 2 x 3 inch strip (see diagram, letter D) parallel with sides of walk, in such position as will form square blocks, of equal dimensions, not over 6 feet wide; brace same with stakes, but do not nail to frame, then cut a strip 2 x 3 inches, the length of which is to be the width of the blocks, or distance between strip D and side frame F. Place this strip so as to form a square block (see diagram, letter C). On inside of strips C and D place thick tar or felt paper one-fourth inch thick and three inches wide; fill in the space thus formed (block A) with concrete composed of one part Portland cement, two and one-half parts sand and five parts crushed stone or gravel, mixed thoroughly. Tamp concrete thoroughly to an even thickness of three inches, then remove strip C; the tar paper will adhere to the concrete. Move strip C to the next position (see diagram

dotted lines block B), place the thick tar or felt paper as before, and proceed the same with each block laying alternately. Put on top coat before the first block made starts to set or harden, and in regular order as blocks were made.

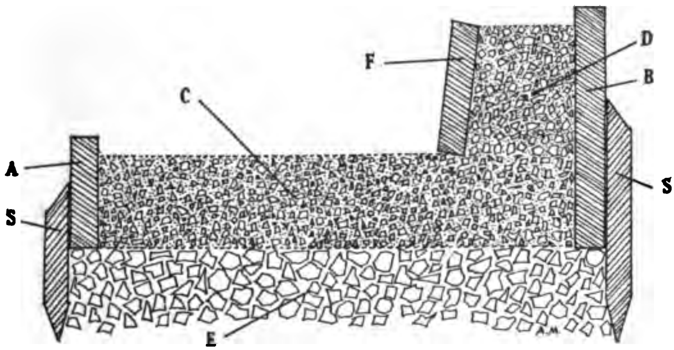
Top Surface.—For wearing surface, mix one part Portland cement with two parts crushed granite or other hard stone, all of which will pass through a quarter-inch mesh screen, or good coarse sand; mix by turning with shovels, raking with a garden rake as each shovelful is turned, turn twice dry and twice wet; add sufficient water to make a plastic consistency so that when floated or troweled very little water rises to the surface. Spread this mortar over concrete base to a thickness of one inch. Work to a flat surface with a straight edge, smooth down with float and trowel after surface water has been absorbed; be careful to get an even surface, bringing no neat cement to the surface and avoiding float and trowel marks.

Cut top surface directly over cuts made in base; cut entirely through top and base all around each block. Finish joint thus made with a jointer and round or bevel all edges.

Monolithic Slab.—As an alternative, and instead of using a top coat, make one slab of selected aggregates for base and wearing surface, filling in between frames concrete flush with established grade. Concrete to be of selected aggregates, all of which will pass through a three-fourths-inch mesh sieve, hard, tough stones or pebbles graded in size, proportioned to be one part cement, two and one-half parts crushed hard stone screenings or coarse sand, all passing a one-fourth-inch mesh, and five parts crushed hard-stone or pebbles, all passing through a three-fourths-inch mesh, and all collected on a one-fourth-inch mesh. Tamp to an even surface, prove surface with straight edge, smooth down with float or trowel, and, in addition, a natural finish can be obtained by scrubbing with a wire brush and water while concrete is "green," but after final set.

Expansion.—Do not allow any block to bear directly against any solid body, such as stone curb, building, post, manhole rim, etc. Leave the same space (about one-fourth inch) between pavement and such fixtures as is between the blocks themselves. This applies to the base and top as designed to avoid cracks and

chipping due to expansion and contraction from temperature changes. This space can be conveniently provided for by the use of thick tar paper or felt, waterproofed with any of the reliable waterproof paints.



CONCRETE CURB AND GUTTER, SHOWING DRAINAGE FOUNDATION AND CONCRETE BASE. (TOP COAT NOT SHOWN.)

A—Plank 1½ inches x 6 inches, length as required.
B—Plank 1½ inches x 13 inches, length as required.
C—Concrete base for gutter and under curb.
D—Concrete base for curb.
E—Drainage foundation.
F—Plank 1½ inches x 7 inches, length as required.
S—Stakes nailed to Forms "A" and "B."

Protection and Seasoning.—Immediately as finished cover pavement so as to protect against rays of sun and drying, raising covering a few inches so as not to come in contact with the surfaces after pavement has reached hard set, sprinkle frequently, two or three times a day, with a garden hose or sprinkler for a week or more.

DISCUSSION.

Mr. E. A. Parsons.—Mr. Moyer, in speaking of the cement stone slab, gave it a maximum size of six feet. The cement slab, as made by a stone machine, under heavy pounding pressure would, to a very great extent, prevent the failure of pavements that are caused by expansion and contraction due to either frost or temperature changes.

It would prevent the possibility of disintegration, because as it would be a unit before being laid it could be inspected before being placed in the sidewalk. We all know the days of the slab, the tile, the brick, the stone and all those things preceded the monolithic laying of sidewalk, and while there is no question about the excellence of the monolithic sidewalk when properly laid and properly made and properly curbed, and properly drained, yet I believe that a cement stone slab, as Mr. Moyer correctly calls it, will be found the only method of securing uniformly good pavements. The ease with which a proper inspection of the material can be made is another feature that recommends slab construction, any faulty material or construction or any tendency to disintegration becoming apparent before the slab enters the pavement.

Mr. E. S. Larned.—I would like to offer a definition for fine sand with which I think Mr. Moyer will agree, and perhaps it would correct his statement. His definition of fine sand is that all of which passes a sixteen-mesh sieve.

Those of us who are engaged in testing material well know that the standard sand adopted by the American Society of Civil Engineers is a sand that passes a twenty sieve and is caught on a thirty, and is finer than that described by Mr. Moyer. Fine sand that we generally encounter in excavation is very different and it is not alone its fineness but its other characteristics that must be taken into account. A great deal of fine sand contains impurities of which you know very little until it is analyzed. If the impurities are of a limy character or a clayey nature it is manifestly unsafe, being more subject to expansion.

Another difficulty with a fine sand is that of intimately mixing the cement with it. It cannot ordinarily be done by hand, but must be done by machinery, and must be mixed a long while. I fully agree with Mr. Moyer that one of the great difficulties of cement work is the use of fine sand, but the trouble is attributable to so many causes. The characteristics of the fine sand itself are varied, and it is not alone the fineness that does the damage. It very seriously retards the hardening of cement and is to be viewed with suspicion.

I would like to take up Mr. Moyer's paper on a few more points. I am, rather, going backward on it, because I did not make any memorandum until rather late in the reading, but I have before me "the use of lampblack." I fully agree with Mr. Moyer, the use of lampblack is in no sense a desirable practice, although if properly used and in proper quantities no serious injury results to the cement.

Referring to the matter of drainage, I wish to call your attention to something I have noticed. You find in a great many of the southern districts sidewalks of one slab width, with an earth and grass quarter on each side. It has been the common practice of contractors doing that work where they put down a drainage foundation to excavate just within the limits of the flag width, and in doing so they are very apt in digging to give the excavation a slope in, giving a wedge foundation. It is obvious that when the frost action occurs it has a pretty good chance to get under that pavement. I advocate in such cases that the excavation be made two or three inches wider than the flag, and the cinder or gravel foundation carried out that distance, but keeping your cement pavement fully within the limits of your drainage foundation. If there will be much water with which to contend and the foundations are subject to hard freezing, it is evident that you have got to provide some run-off for accumulated water. That is simply a matter of common sense, and any man who knows the purpose of drainage will see that without argument.

I wanted to speak of Mr. Moyer's suggestion of raking the concrete. I fully agree with him that where mortar is made with shovels a better mixture will result if that is supplemented by

raking, because it serves to break up a tendency to ball or cake, and distributes the water and also the cement a little bit better through the mortar. But I do not agree with that proposition when you are making concrete. If you attempt to rake concrete, as it is ordinarily done by a man who does it in a very mechanical manner, without really knowing what he is doing, except that he is manipulating a rake, he will come pretty near undoing the work of mixing. He will separate the stones from the mortar. I believe that the integrity and value of concrete depends absolutely on the mortar, and if so, where you are making hand-mixed concrete, you had better make a mortar first. Bricklayers, stonelayers, all appreciate the manipulation in a mortar. The more the mortar is tamped and cut in the tube from which the mason takes it on his trowel, the smoother it is and the better it is. That is simply because the materials are thoroughly incorporated. If you make a good mortar first and then use a good aggregate you are going to get a good concrete. If you attempt to mix your materials dry and add water it is almost impossible to bring your cement and sand into intimate association in the presence of sand or a coarse aggregate. You might by repeated turnings—or by using a mechanical mixer—but the ordinary handturning will not result in as intimate a mixture as if you made your mortar first.

As a means of preventing the surface of sidewalks from drying out I believe that sawdust is a good and easily handled material. It is light, it is easily brought into the work and can be taken away more cheaply than sand. If pavement is covered with several inches of sawdust thoroughly wet and kept wet for the requisite time, it serves the purpose very well.

As far as I know this leaves no permanent stain. Occasionally, when the sawdust is first removed, if it comes from a pitchy material like pine wood, there is a suggestion of a stain. But that, in every instance I have ever observed, is washed off. It has not penetrated. Of course, neither sand or sawdust are spread until the pavement is hard enough to prevent its adhering.

The importance of preventing concrete work drying out cannot be too strongly emphasized, and one of the great oversights in all foundation work is in the preparation of the founda-

tion by consolidating it by ramming or rolling and then not wetting it. No concrete should be put on the earth surface until the earth surface has been thoroughly wetted. It ought to be screened, and then there is no chance of the earth drawing the water from the concrete which is needed for crystallization. That applies particularly to foundations for street pavement which are made on a large scale. Oftentimes the excavation is made rather imperfectly and the foundation is not given the curve which is even with the road surface. There are pockets, ridges, all of which are more or less loose, and in walking or working over it the matter is disturbed, causing irregularity in the foundation. But if that surface is rolled in advance of your concrete and thoroughly wet, you will get a foundation that you do not ordinarily see in work of that kind.

Mr. Moyer also suggests the possibility of securing a wearing surface without the use of what we commonly call a granolithic finish. I thoroughly believe that is a very valuable suggestion, and I have used it this past year in floor construction with very excellent results. The method of doing that was as follows: We used a coarse and fairly rich mixture, but inasmuch as the floor was carrying loads of 150 pounds per square foot, it was designed and reinforced to perform that work, and this necessitated a comparatively rich mixture. We borrowed a roller about thirty inches in diameter and faced it with a steel plate, and instead of ramming that surface we rolled it back and forth. That drove the coarser material pretty well into the body of the concrete. Then it was screened and floated without any top finish whatever. It was smooth and uniform, and one of the most perfect floors I have ever seen.

MR. O. U. MIRACLE.—I think a sand joint between each block is a great waste of labor, time and material. In the first place, it is difficult to find those joints again when you are cutting through the top and making a dust-proof joint. A walk made in that manner, if the blocks rise, permits one block to slip up past the other, but not to slip back in place readily.

Another point I would like to mention is in connection with trouble with loose tops. I have not heard anything said either about a rough surface or a smooth surface for the concrete before

the top coat is applied. I have found in our practice that it is best to go over the concrete lightly with a trowel and smooth it off as smoothly as possible before applying the top coat. If there are loose particles left lying around on the top and lower layer of concrete permitted to dry out, as Mr. Moyer suggested, in many cases the top coat will loosen.

MR. WILLIAM SEAFERT.—I wish to add to the discussion on lampblack something that has come under my own observation. I had occasion to take up a concrete pavement with a diamond design, such as were made thirty years ago. The diamonds were black and white, and the black was, of course, adulterated with a very high-grade lampblack. Examinations of these pavements will show that the light portions of those diamonds are worn right out, whereas the black adulteration is just as good to-day as when laid and is like glass. I put down a sidewalk twenty years ago and the lampblack-treated concrete was so hard it would turn a tool. Such results can, however, only be obtained by using an excellent variety of lampblack.

PRESIDENT RICHARD L. HUMPHREY.—It seems to me that in the discussion of the pavement question we have to deal with two classes of work which are somewhat differently affected by climatic conditions. One is the sidewalk which is laid in the country, where it has earth on each side, and the other the pavement which is laid in the city, where it touches the curb on one side and the building on the other and where the action of frost is not so great as it would be where the earth surrounds it.

Concrete, as you know, is a very poor conductor of temperature. Perhaps some of the difficulties which are encountered in sidewalk work by reason of the swelling or expansion occur where the thickness of the concrete is very small. In other words, a pavement which may be three and one-half or four inches thick would be more affected by the action of the temperature than a pavement which was six inches thick, because the effect of changes of temperature on that mass would be less. Of course, pavements may fail from bad workmanship; they may fail from bad material; and in some of the pavements which I have inspected the failure has been due partly to bad workmanship and partly to bad material. That covers the sand and gravel and other materials which may be used in the aggregate.

Atmospheric and ground conditions, when the pavement is laid, influences its behavior to a great extent. In summer time, where the two coats are put on, they may not be properly protected from the sun. The base may dry out; the top coat may dry out too quickly. Shrinkage may be produced. Now, as to the effect of ground conditions. Some sub-soils are so porous that the water drains away very freely and the pavement is submitted to what might be called dry conditions. In other cases, it may be a damp foundation, and the concrete is kept uniformly damp. I think we all know that concrete in air has a tendency to shrink; submerged in water, it has a tendency to expand. It is this difference in local conditions which largely determines the question of expansion. I do not believe it would be possible to give you figures of the probable expansion.

The question that has been raised in regard to the kind of sand and the size of grain is, of course, an interesting one, but the most important feature of sand or crushed stone or material which you combine with cement, is the question of voids. It is the amount of void space which may be in that material. On that depends the excellence of your concrete. The fine sands are not desirable. As has been stated, the grains are generally about the same size, so that the percentage of voids is great. Again, the character of the sand has a great deal to do with the mixing, and it is difficult to incorporate a fine sand with the cement properly, and I quite agree with Mr. Larned that it is immeasurably better to mix your mortar first and then mix your aggregate with it than attempt to mix them dry and add the water afterwards.

REINFORCED CONCRETE.

BY W. K. HATT.*

It was a comfortable assurance of that urbane Roman poet, Horace, that he had built himself a monument more lasting than brass in the intellectual life of mankind. At the time that he was writing these lines the Roman engineers were constructing these concrete aqueducts and domes that have served mankind on the physical side during the time that Horace h been a source of perpetual delight to the students of clas writings. Which product will endure the longer is an open tion. One thing is certain, while many persons of exquisite taste may prefer Horace to our modern writers, most well-informed persons conclude that the engineer of to-day has surpassed the Roman engineer in the quality and use of concrete.

The number of recent failures of reinforced concrete buildings, attended with the loss of life of workmen, does not constitute an argument against the advance of the practice of this new art, but calls attention to the need of correct theory in design and expert supervision in construction. Steel for buildings is made under highly technical methods and a searching inspection by trained men, whereas concrete for buildings may be formed by ignorant and unskilled workmen, and may be supervised by foremen who are inexperienced in the art of proportioning and mixing the ingredients. Defective material, either of cement, sand or stone, dishonest skimping of cement and poor inspection, incorrect proportioning, and a too early removal of the wooden forms from the floors molded in cold weather, or heavily laden with stored cement and other materials, are sufficient causes to explain these failures. An increasing number of these may be expected as time goes on, and untrained men who have learned their business in other lines of construction take up the work of building reinforced concrete structures. The

*Professor of Civil Engineering, Purdue University, Lafayette, Ind.

resulting loss of life will no doubt call attention to the necessity of regulating by proper building laws this new construction, which has spread so rapidly over the country from sea to sea. In 1902, when the first published results of experimentation appeared from the laboratory for testing materials of Purdue University, one had to go far to observe instances of reinforced concrete. Last summer in Seattle the writer saw no other type of building in process of construction. At Atlantic City in 1902, when the experiments referred to were placed before the American Society for Testing Materials, there were no instances of the use of reinforced concrete in sight. Last summer at the meeting of the Society one viewed the stately and beautiful Marlborough-Blenheim Hotel entirely constructed of reinforced concrete; the replacement of the steel pier by reinforced concrete piles and girders; and the construction of a new recreation pier of this type of construction. The growth has been truly marvelous. Not only has the extent of its use in bridges and buildings increased, but the variety of its application is extraordinary. In a list of construction in which it is successfully and economically used may be included: Retaining walls, dams, tanks, conduits, chimneys, arches, culverts, foundations, floors for buildings, railroad girders, highway bridges, pipes, railway ties, piles, stairs and roofs.

At the present time the underlying mechanical principles and the constants of design of beams are fairly well determined, and we wait upon the architects to express the truth of these principles in a beautiful structure. While this type of construction associates itself with the broad and simple wall spaces and low buildings of the Spanish Mission style, with surface ornaments of tiling and Mosaic, it also lends itself to important modern civic buildings. The stateliness of beauty of the Marlborough-Blenheim Hotel at Atlantic City has been mentioned. The Ingalls Building, Cincinnati, and the New Terminal Station at Atlanta, Ga., are other examples.

Without stopping to discuss the properties of waterproofness, fireproofness, durability, etc., or the multitude of topics of interest and importance that crowd upon one's mind in connection with reinforced concrete, attention will be simply called to the mechanical principles underlying the construction.

Concrete, like stone, is weak in tension, but strong in compression at a ratio of 1 to 10. Consequently when under flexure, as in a beam, the concrete is not used economically, for it breaks on the lower side in tension before the compressional strength is utilized. A beam may be, however, strengthened, or reinforced, by the insertion of a steel rod in the lower side of the beam. These rods are usually bent up near the ends of the beam so as to also reinforce the beam against the diagonal tensional stresses that occur at the ends, due to the combination of shear and direct stress.

Before the rod can come into operation during a flexure of the beam there must be the necessary adhesion between the concrete and the rod to transfer the stress to the rod. This adhesion or bond varies from 200 pounds to 500 pounds per square inch of the surface of a plain rod, and under favorable conditions is sufficient to develop the strength of the steel in the concrete. The adhesion is thought to be more of a mechanical action than chemical, and is due to the entrance of the fine cement into the microscopic pits on the surface of the smooth rods. Many designers use artificially deformed bars, such as corrugated bars and twisted steel bars to increase this adhesion.

Some engineers have feared the effect of long continued vibrations on the bond of the steel or the strength of the concrete.

It is well known that concrete, because of its lack of elasticity, absorbs or deadens vibrations, and the sound caused thereby. It is not probable that vibrations reach the steel. The speaker has knowledge of many experimental attempts to loosen the bond by shocks and vibrations. So far smooth bars encased in concrete that have been subjected to shocks and long-continued vibrations seem not to have lost any of their original strength of bond. Likewise the concrete on the compression side of a reinforced concrete beam that has been loaded and released from load some 2,500 times to high working stresses seems not to have been substantially weakened thereby.

In this way a beam is reinforced so that both the concrete in compression and the steel in tension may be worked to their full value. Any one who has seen a plain concrete beam broken in a testing machine, and then has witnessed a test of a rein-

forced concrete beam will be first of all struck by the apparently greatly increased flexibility of the reinforced concrete beam, which deflects ten times as much as the plain beam before showing, in the case of a dry beam, any cracks to the naked eye, and when the load is removed the elasticity of the steel draws the beam back nearly to its original shape. It is probable, however, that this process of bending the reinforced concrete beam develops very minute flaws in the concrete which are invisible to the naked eye, unless the concrete has been soaked in water, so that it is not safe to count upon a tensile strength of the concrete in computing the total resisting strength of the beam at the usual working stresses. Small fissures are, no doubt, present in the concrete before the stress is applied. Designers usually compute the resisting moment of the beam as based upon the compressional stresses in the concrete and the tensional stress in the steel alone.

Engineers as a rule have found it necessary to review their knowledge of mechanics in dealing with reinforced concrete, not that there is any new principle involved, but the number of factors in the equations of flexure is greater, and an account must be taken of the relative moduli of elasticity of the two materials, steel and concrete. Furthermore, the lack of perfect elasticity of the concrete under certain conditions leads to an assumption of some other than a rectilinear relation between stress and strain.

In calculating the strength of the reinforced concrete beam, sufficiently approximate results can be obtained by omitting consideration of the tensile stresses in the concrete, and supposing a rectilinear relation between stress and strain. The moment of flexure is then most simply expressed as the total force in the steel multiplied by the distance to the centroid of the compressive stresses. This latter distance is expressed with sufficient accuracy as a fraction of the depth of the beam, this fraction having been determined by experimental measurement on the tested beams.

Care in all cases must be taken to compute the maximum compressive stress arising in the concrete under the conditions of the problem, and also the amount of diagonal tension at the ends of the beams must be computed and provided for by stirrups, or by bending up some of the rods at the ends.

The question of lumber for forms in reinforced concrete construction is one of increasing importance. The scarcity of lumber is reflected in the increasing price. This is not a temporary condition, but is justified by the economic conditions. It is a well-known fact that the forest resources are rapidly becoming depleted, and that we are rapidly approaching the time when we shall feel the pinch of a timber famine. Even at the present time the lumber cost for forms in reinforced concrete construction is a considerable item. The progress of design may be largely in the direction of casting the materials in permanent forms and then erecting them, and of so designing the building and centering that these may be simple and inexpensive, and that the sequence of operations will result in the use of as little lumber as is necessary. The organization of the United States which has given a large amount of attention to the study of the supply of timber and the methods of preparing it for the market, and its value for structural purposes, is the Forest Service of the United States Department of Agriculture. Members of this association who wish information concerning our timber supplies, and their quality, will do well to apply for the publications of the Forest Service. They can be had by addressing the Forester, Forest Service, U. S. Department of Agriculture.

To conclude this brief consideration of reinforced concrete, a conservative estimate would include the following principles:

1. Concrete is durable and fireproof when made of the proper aggregate.

2. The strength of combinations of steel and concrete may be calculated with a sufficiently close degree of accuracy.

3. Shapely and beautiful structures may be built of this material. It is particularly adapted for mill buildings because of the absence of vibrations, which are induced in the ordinary type of mill buildings by the rapidly revolving machinery.

4. The cost of a properly designed reinforced concrete building, where wooden forms are used to advantage, is said not to exceed more than 5 or 10 per cent of the cost of the mill buildings of the ordinary type with brick walls and wooden beams of the so-called slow-burning construction, provided that the concrete may be laid, as at present, by unskilled labor.

DISCUSSION.

Mr. C. M. Maynard.—There has been a great deal of discussion about the expansion and contraction of concrete. Does steel reinforce that contraction and expansion to a certain extent?

Professor Hatt.—Steel acts to some extent like hair does in plaster. It prevents big cracks forming. The cracks that form are small. You cannot see them. The effect of heat is to expand the steel and to expand the concrete, but that amount of expansion is very nearly the same. So, answering the question directly, the effect of steel in concrete is to help it withstand the changes in temperature without cracking.

Mr. C. N. Barker.—I would like to ask Professor Hatt what has been his experience in regard to the relative bond value of round and square rods.

Professor Hatt.—The bond on a round rod is greater than that of a square rod, because cement sets better around a round object than around a square object.

FORMS FOR CONCRETE CONSTRUCTION.

By Sanford E. Thompson, M.Am. Soc. C. E.*

Recent failures in reinforced concrete construction cannot be cast to one side and forgotten with the passing comment so frequently heard that the accident was due merely to poor construction or too early removal of forms. The reasons for every failure should be thoroughly investigated by experts to prevent recurrence of similar accidents.

"Forms," although frequently guilty, are by no means the only culprits. In fact they are frequently blamed when the designer is at fault. Just so long as men who know nothing of the first principles of mechanics are permitted to design concrete structures, and just so long as irresponsible contractors are engaged to erect them, the list of accidents will increase in startling numbers. In every case it is the men, not the inanimate lumber and materials, who are to blame. However, granting its danger under ignorant hands, reinforced concrete as a whole must not be condemned for failures due to improper conditions any more than brick should be rejected as a building material for apartment houses, because of the collapse of several unfinished buildings in New York City two years ago through disregard of frost action upon the mortar.

Failures in concrete buildings may be attributed to:

1. Imperfect design; especially through neglect of essential details in locating the reinforcing metal, and through the adoption of too low a factor of safety.

2. Poor materials; such as cement which does not properly set up, or sand which is too fine or which has an excess of clay, loam or other impurities.

3. Faulty construction; from improper proportioning, mixing or placing, or too early removal of forms.

4. Weak forms.

* Consulting Engineer, Newton Highlands, Mass.

A disregard of such important principles is frequently criminal negligence, and yet in at least one case under my observation an examination of the structure and the materials, after a collapse in which a number of lives were lost, showed the design, materials and construction all faulty, so that it was impossible to decide positively which of the four causes named above was the primary reason for the failure.

In this paper it is proposed to treat only of the design, construction and removal of forms.

GENERAL RULES FOR FORM CONSTRUCTION.

Kind of Lumber.—The selection of the lumber must be governed by the character of the work and the local market. Although white pine is best for fine face work and quite essential for ornamental construction cast in wooden forms; for ordinary work, even for the panels, white pine is apt to be too expensive, and spruce, fir, Norway pine or the softer qualities of southern pine, especially North Carolina pine, must be substituted for it. Some of these woods are more liable to warp than white pine, but they are generally stiffer and thus better adapted for struts and braces.

Kiln dried lumber is not suitable for form construction because of its tendency to swell when the wet concrete touches it. Very green lumber, on the other hand, especially southern pine, which does not close up quickly when wet, may give trouble by joints opening. Therefore, the middle ground, or, in other words, partially dried stuff, is usually best.

Finish and Thickness of Lumber.—Either tongued-and-grooved or bevel-edged stuff will give good results for floor and wall panel forms, and is preferable to square-edged stuff. A smoother surface may be attained at first with the tongued-and-grooved stock, and there is less trouble with opening joints, but it is more expensive than bevel-edge because of the waste in dressing, and if the forms are used many times there is greater tendency to wear at the joints. Even for rough forms, plank planed one side may be economical to cheapen the cost of cleaning. Studs should always be planed one side to bring to size.

5

The thickness of lumber varies with different contractors, some using one-inch, other one-and-a-half-inch, while a few employ two-inch stuff even for panels. (These are commercial thicknesses measured before planing.) For ordinary walls one-and-one-half-inch stuff is good, although for heavy construction, where derricks are used, two-inch is preferable. For floor panels, one-inch boards are most common, although if the building is eight stories high or over, one-inch stuff is likely to be pretty well worn out before the top of the building is reached and the under surface of the concrete may show the wear badly. For sides of girders either one-inch or one-and-one-half inch is sufficient, while two-inch is preferable for the bottoms of girders. Column forms are generally made of two-inch plank.

DETAILS OF FORM CONSTRUCTION.

Certain general rules are applicable to all kinds of forms. Strength, simplicity and symmetry are three fundamental principles of design. The necessity for strength is obvious, while economy in concrete construction consists in quickly erecting and moving the forms and in using them over and over again.

The design of the concrete members should recognize the forms. A slight excess of concrete sometimes may be contributed to save carpenter work. Frequently beams may be designed of such widths as to use dimension widths of lumber without splitting.

Columns may be of dimensions to avoid frequent re-making. Panel recesses in walls may be made the thickness of a board or a plank. To permit ready cleaning of dirt and chips from the column forms before laying the concrete, at least one prominent contractor provides a door at the bottom of each of them.

In building construction the forms must be designed so that the column molds and also the bottom of beam molds are all independent of the slabs. The forms may thus be left a longer time upon members subjected to the greater stress.

The sides of the beam molds should be held tightly together by wedges or clamps, to prevent the pressure of the concrete springing them away from the bottom boards. At top or bottom of each strut hard wood wedges are useful when setting and

removing it and also permit testing to make sure that there is no deflection of the beam or slab. For this purpose some contractors loosen the wedges twenty-four hours in advance of the struts. In general, it is preferable to use comparatively light joists, such as 2 x 8 inches or 2 x 10 inches, with frequent shores, rather than to use lumber which is heavier to handle.

If forms are to be used but once or must be taken apart when removed, it is sometimes practicable to use only a few partially driven nails so that they can be withdrawn without injury to the lumber. It is very difficult to convince house carpenters that the pressure of the concrete will hold temporary panel boards in place with scarcely any nailing.

Alignment is another item of importance, since it is here that a great deal of time may be wasted by inexperienced or incompetent carpenters. Such workmen may err either on the side of poor alignment or more careful alignment than the structure requires. Mr. W. J. Douglas* suggests as a general rule the allowance of "three-eighths inch departure from established lines on finished work and two inches on unfinished work."

In removing forms the green concrete must not be disturbed by prying against it. This seems so obvious as to need no emphasis, but I have known a first-class house carpenter to actually attempt to straighten a wall which was an inch out of line the day after the concrete was laid by prying the forms over. The wall was straightened, but by a different process from that proposed by the carpenter—the concrete was relaid.

Forms for facework should be tightly put together, it being advisable in some cases to close the joints and holes by mortar, putty, plaster of Paris, sheathing paper or thin metal. This is not, as is commonly supposed, to prevent loss of strength by the cement which flows out with the water, but rather to prevent the formation of voids or stone pockets in the finished surface.

Crude oil is one of the best materials to prevent adhesion of the concrete to the forms, though linseed oil, soft soap and various other greasy substances are also employed for this purpose. The oil or grease should be thin enough to flow and fill the grain of the wood.

**Engineering News*, December 20, 1906, p. 646.

If the forms are to be left until the concrete is hard, there is little danger of the concrete sticking to them if instead of being greased they are wet thoroughly with water before the concrete is laid. In any case, if concrete adheres to the forms it should be thoroughly cleaned off before resetting; even then it is apt to stick again in the same place.

DESIGN OF FORMS.

"Rule of thumb" layout of forms in the field is being superseded by design in the drawing room. In building construction where the forms form a large percentage of the cost of the building and where a failure in the forms may cause loss of life, it is especially necessary to treat this question from an engineering standpoint, and many of the best concrete contractors now design their forms as carefully as the dimensions of the concrete members.

If a minimum quantity of lumber is to be used consistent with the deformation allowed, it follows that the dimensions and spacing of the supporting lumber must be actually computed from the weight or the pressure against the sheeting. For columns and for walls where a considerable height of wet concrete is to be placed at once the pressure may be calculated as a liquid. Mr. W. J. Douglas* assumes that the concrete is a liquid of half its own weight, of 75 pounds per cubic foot.

In ordinary walls where the concrete is placed in layers computation is not usually necessary, since general experience has shown that maximum spacing for 1-inch boards is 2 feet, for 1½-inch plank is 4 feet, and for 2-inch plank is 5 feet. Studding generally varies from 3 x 4 inches to 4 x 6 inches, according to the character of the work and the distance between the horizontal braces or waling.

Floor forms are better based upon an allowable deflection than upon strength, in order to give sufficient stiffness to prevent partial rupture of the concrete or sagging beams.

In calculating, we must add to the weight of the concrete itself, *i. e.*, to the dead load, a construction live load which may be assumed as liable to come upon the concrete while setting. Definite units of stress must also be assumed in the lumber.

**Engineering News*, December 20, 1906, p. 646.

I would suggest the following basis for computation, these being values which I have adopted after quite thorough consideration of the matter:

(1) Weight of concrete, including reinforcement, 154 lbs. per cu. ft.
(2) Live load—75 lbs. per sq. ft. upon slab;
50 lbs. per sq. ft. in figuring beam and girder forms; and struts.
(3) For allowable compression in struts use 600 to 1,200 lbs. per sq. in., varying with the ratio of the size of the strut to its length. (See table below.) If timber beams are calculated for strength, use 750 lbs. per sq. in. extreme transverse fiber stress.
(4) Compute plank joists and timber beams by the following formula, allowing a maximum deflection of 1/8 inch:

$$d = \frac{3}{384} \frac{Wl^3}{EI} \qquad (1)$$

and

$$I = \frac{bh^3}{12} \qquad (2)$$

in which

d = Greatest deflection in inches.
W = Total load on plank or joist.
l = Distance between supports in inches.
E = Modulus of elasticity of lumber used.
I = Moment of inertia of cross-section of plank or joist.
b = Breadth of lumber.
h = Depth of lumber.

The formula is the ordinary formula for calculating deflection except that the coefficient is taken as an approximate mean between 1-384 for a beam with fixed ends and 5-384 for a beam with ends simply supported.

For spruce lumber and other woods commonly used in form construction, E may be assumed as 1,300,000 pounds per square inch.

Formula (1) may be solved for I, from which the size of joist required may be readily estimated from formula (2).

The given weight of concrete per cubic foot is somewhat higher than is frequently used, but is none too much where a dense mixture and an ordinary percentage of steel is used. For very rough calculation, however, it is frequently convenient to remember that 144 pounds per cubic foot is equivalent to the product of the dimensions of a beam in inches times a length of one foot.

The suggested live load is assumed to include the weight of men and barrows filled with concrete and structural material which may be piled upon the floor, not including, however, the weight of piles of cement or sand or stone, which should never be allowed upon a floor unless it is supported by concrete sufficiently strong to bear the weight, or by struts under all the floors below.

The units for stress in struts are somewhat higher than in timber construction because the load is a temporary one. The extreme variation given is due to the fact that when a column or strut is longer than about sixteen times its smallest width there is a tendency to bend which must be prevented either by bracing it both ways or allowing a smaller load per square inch. For struts ordinarily used the following stresses may be assumed for different heights:

SAFE STRENGTH OF WOOD STRUTS IN FORMS FOR FLOOR CONSTRUCTION.

Pounds per sq. in. of cross section.

LENGTH OF STRUT.	DIMENSIONS OF STRUT.			
	3″ x 4″	4″ x 4″	6″ x 6″	8″ x 8″
ft.				
14	....	700	900	1100
12	600	800	1000	1200
10	700	900	1100	1200
8	850	1050	1200	1200
6	1000	1200	1200	1200

Bracing both ways will of course reduce the length of a long strut.

If the concrete floor is comparatively green, the load must be distributed by blocking, preferably of hard wood. At the top of the strut provision must be made against crushing of the wood of the plank or cross-piece. Ordinary soft wood will stand, without crushing, only about 700 pounds per square inch across the grain, so if the compression approaches this figure, brackets must be inserted or hard-wood cleats used.

TIME TO MOVE AFTER PLACING.

The best contractors have definite rules for the minimum time which the forms must be left in ordinary weather, and then these times are lengthened for changes in conditions according to the judgment of the forman.

Correspondence with a number of prominent contractors in various parts of the country, including the Aberthaw Construction Company, Boston; the Expanded Metal and Corrugated Bar Company, St. Louis; the Ferro-Concrete Construction Company, Cincinnati; the Trussed Concrete Steel Company, Detroit, and the Turner Construction Company, New York, indicate substantial agreement in the minimum time to leave forms. As a guide to practice, the following rules are suggested, these following in the main the requirements of the Aberthaw Construction Company:

Walls in mass work: one to three days, or until the concrete will bear pressure of the thumb without indentation.

Thin walls: in summer, two days; in cold weather, five days.

Slabs up to 6 feet span: in summer, six days; in cold weather, two weeks.

Beams and girders and long span slabs: in summer, ten days or two weeks; in cold weather, three weeks to one month. If shores are left without disturbing them, the time of removal of the sheeting in summer may be reduced to one week.

Column forms: in summer, two days; in cold weather, four days, provided girders are shored to prevent appreciable weight reaching columns.

Conduits: two or three days, provided there is not a heavy fill upon them.

Arches: of small size, one week; for large arches with heavy dead load, one month.

All of these times are, of course, simply approximate, the exact time varying with the temperature and moisture of the air, and the character of the construction. Even in summer during a damp, cloudy period, wall forms sometimes cannot be removed inside of five days with other members in proportion. Occasionally, too, batches of concrete will set abnormally slow either because of slow setting cement or impurities in the sand, and the foreman and inspector must watch very carefully to see that the forms are not removed too soon. Trial with a pick may assist in reaching a decision.

Beams and arches of long span must be supported for a longer time than short spans because the dead load is proportionately large, and therefore the compression in the concrete is large even before the live load comes upon it.

The general uncertainty and the personal element which enters into this item emphasize the necessity for some more definite plan for insuring safety. The suggestion has been made that two or three times a day a sample of concrete be taken from the mixer and allowed to set on the ground under the same conditions as the construction until the date when the forms should be moved. These sample specimens may be then put in a testing machine to determine whether the actual strength of the concrete is sufficient to carry the dead and construction loads. Even this plan does not provide for the possibility of an occasional poor batch of concrete, so that watchfulness and good judgment must also be exercised.

EXAMPLES OF FORM DESIGN.

I have selected a number of illustrations of typical modern form construction.

The centers for an eight-foot conduit used by the T. A. Gillespie Company in the Pittsburgh Filtration system is shown in Fig. 1. You will notice that the form is built in sections bolted together so as to be easily taken apart.

The patented Blaw centering is illustrated in Fig. 2. The shell is of steel with turnbuckles provided to collapse the metal, as shown in the upper half of the figure.

In the Pittsburgh filter galleries a very large number of columns were erected for supporting the groined arch roof. Many of these columns were molded in steel centering shown

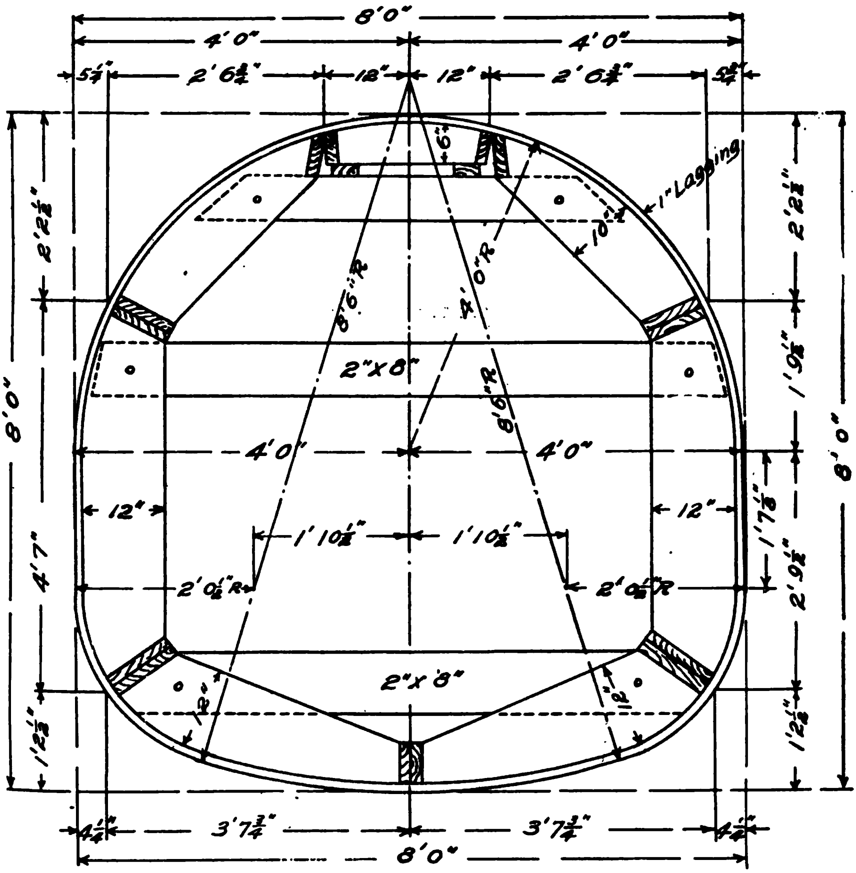
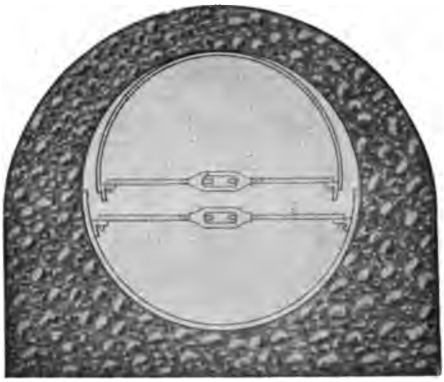


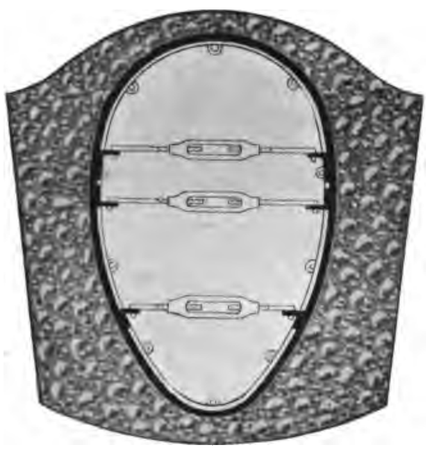
FIG. 1.—CENTER FOR 8-FOOT CONDUIT.

in Fig. 3, this being economical because of the large number of times which it could be used over and over.

A more common style of column forms is that employed in the erection of the Harvard Stadium, as shown in Fig. 4. The slotted form of clamp does not give such stiff centering as another type which I will show later in connection with building forms.



"BLAW" CENTERS COLLAPSED.



"BLAW" CENTERS IN POSITION.

FIG. 2.

In Waltham, Mass., a concrete reservoir or standpipe 100 ft. in diameter by 42 ft. high has recently been constructed under the direction of Mr. Bertram Brewer, City Engineer. The forms, were designed by the contractors, Simpson Brothers Corporation.

Fig. 5 illustrates the construction of a heavy wall where the ties consist of wire twisted to hold the sides of the forms in place.

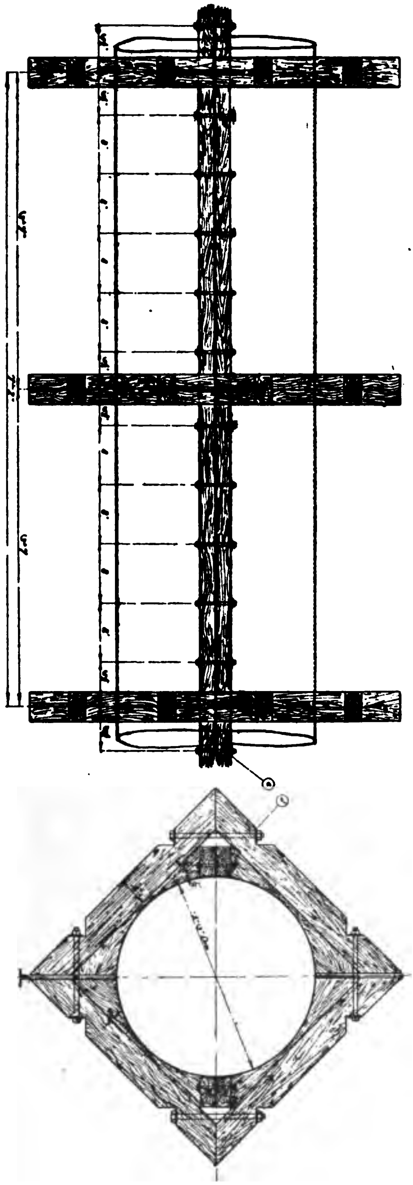


FIG. 3.—STEEL FORMS FOR PIERS IN THE PITTSBURG FILTRATION GALLERY.

FIG. 4.—MOLDS FOR COLUMNS AT HARVARD STADIUM.

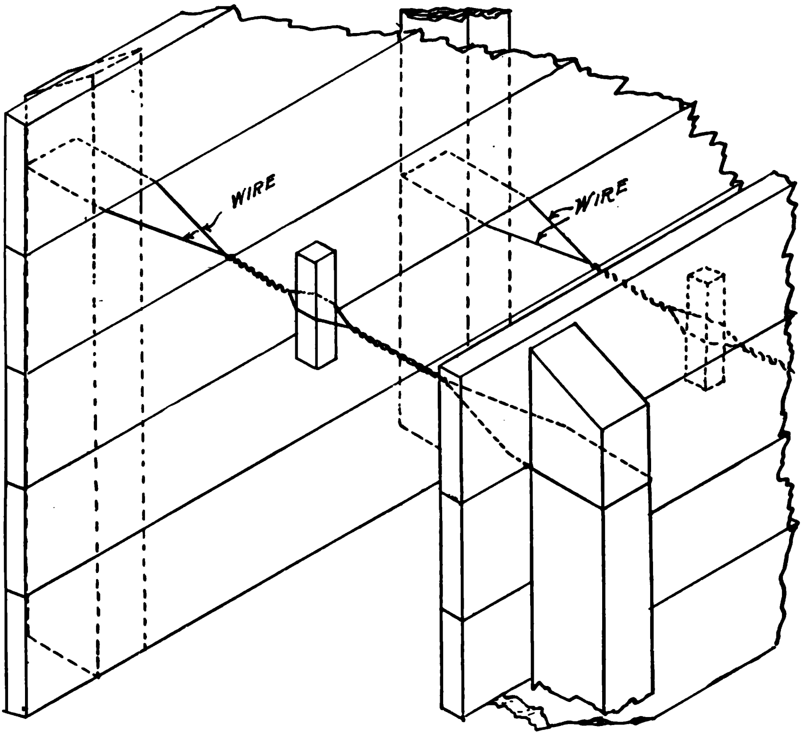


FIG. 5.—FORM FOR HEAVY WALL.

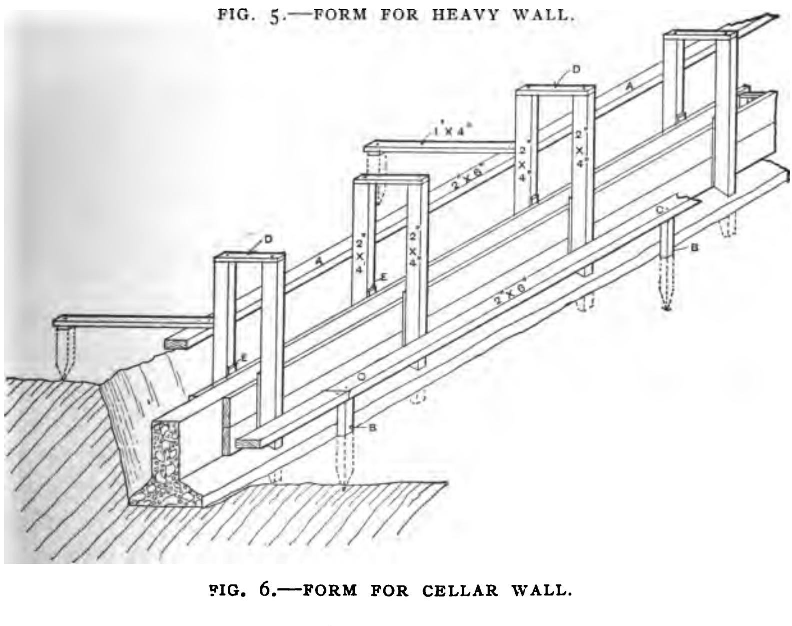


FIG. 6.—FORM FOR CELLAR WALL.

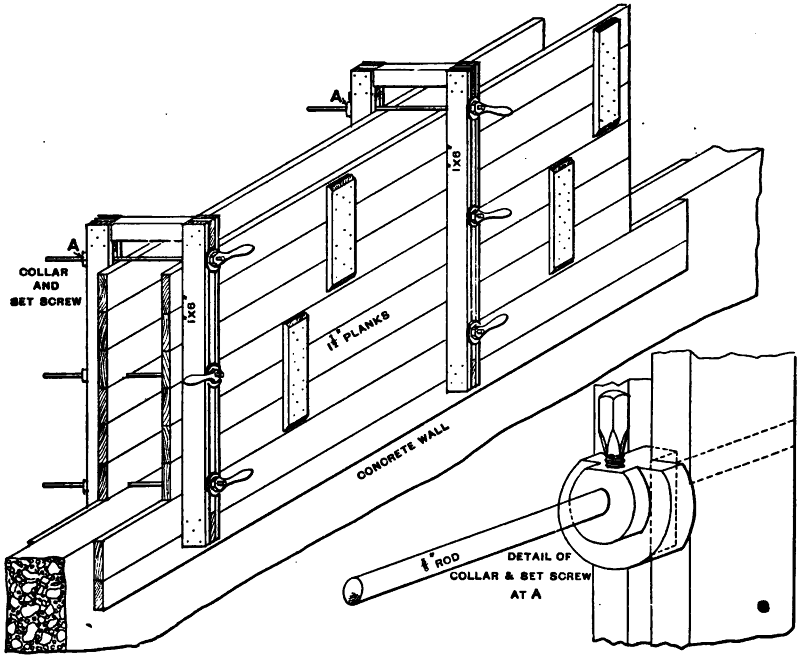


FIG. 7.—MOVABLE WALL FORMS.

A simple form of construction for a low foundation wall is given in Fig. 6.

Fig. 7 illustrates a common form of building a wall of greater height. As soon as a section is completed, the bolts are loosened, and the slotted form of clamp or brace permits it to be readily moved upward. This slotted construction was designed by Mr. E. L. Ransome, one of our pioneers in concrete construction.

Forms for hollow walls are shown in Fig. 8.

A style of wall construction has been designed, and patent applied for, by Mr. S. H. Lea, using for the forms metal lathing which has first been plastered on the outside. (See Fig. 10.)

Beam and column forms such as are used in ordinary building construction are shown in Figs. 9 and 11. This is a common type with certain features designed by Mr. Robert A. Cummings, from whose drawings the photograph has been made. To hold

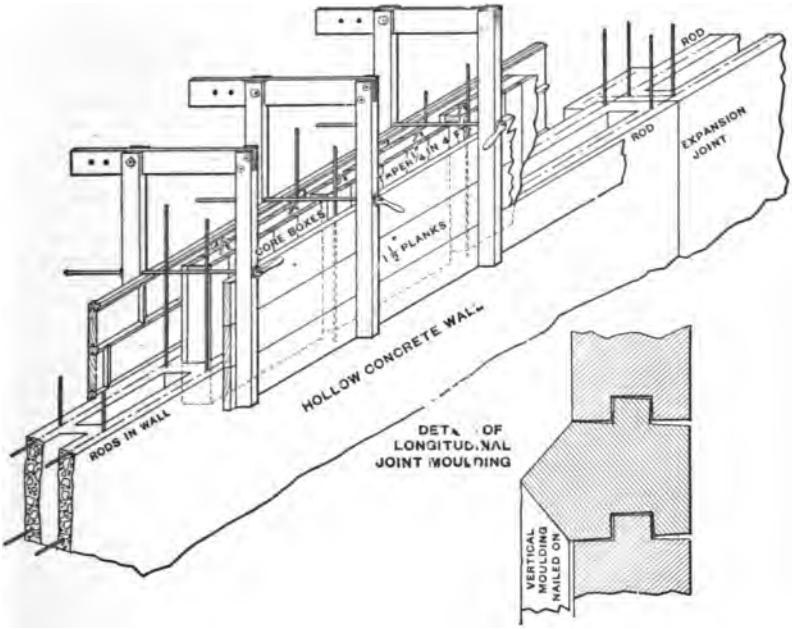


FIG. 8.—FORMS FOR HOLLOW WALLS.

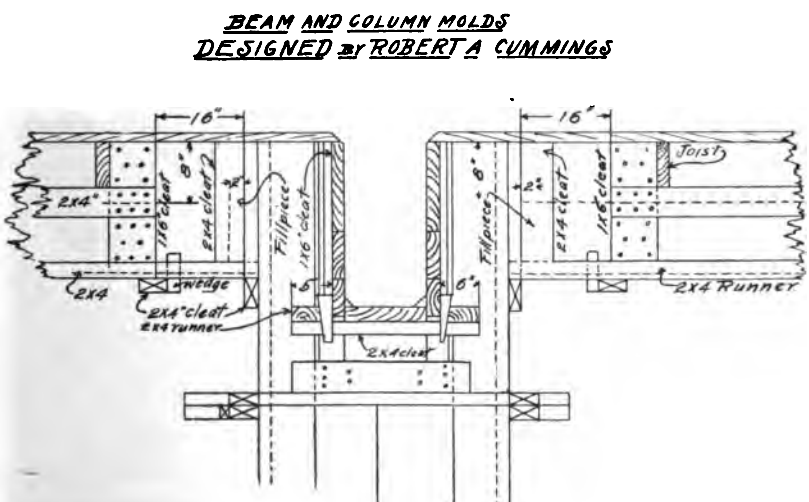
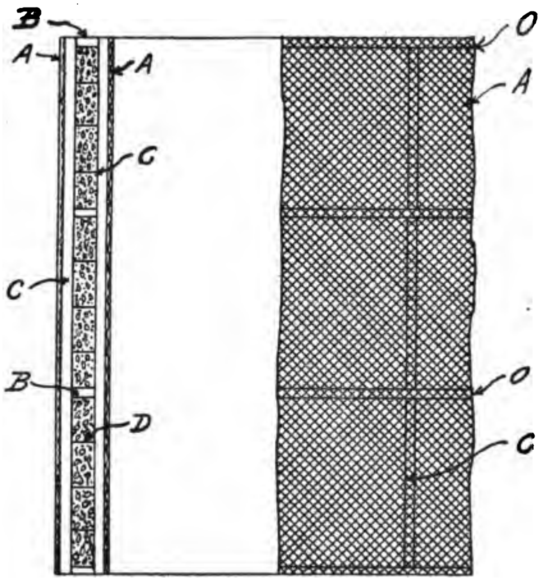


FIG. 9.—TYPICAL FORMS IN BUILDING CONSTRUCTION.



EXPLANATION.

A = Wire Fabric.
B = Spacing Bar.
C = Vertical Member.
D = Separator.
O = Horizontal Member.

A frame of the desired form is erected of structural steel and covered with wire fabric as shown. A coating of cement or mortar is then applied to the outside of the wire fabric which, upon hardening, forms a shell of the desired outline, which may be filled in with concrete. This method of construction does not require the use of forms or molds, thus effecting a great saving in material and labor, besides affording a strong, well-finished structure. It may be employed in building dams, retaining walls, culverts and other structures.

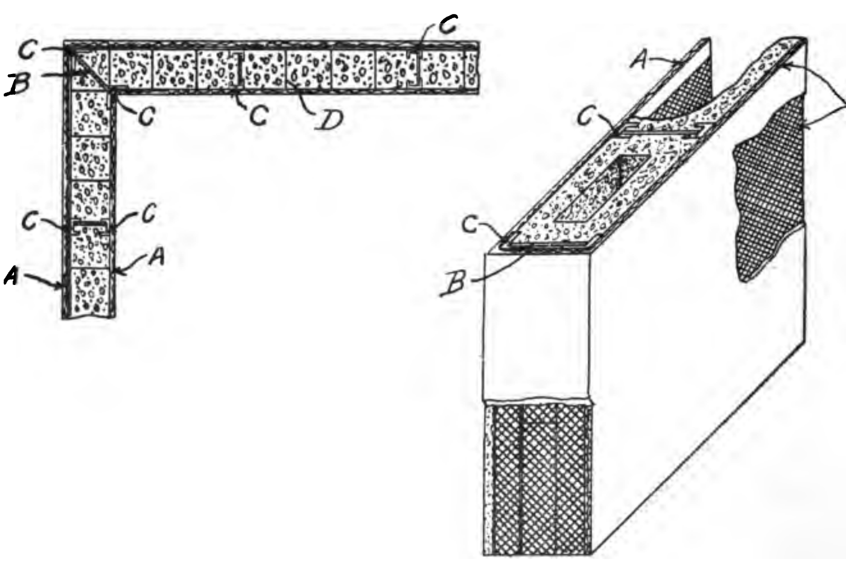


FIG. 10.—CONCRETE-METAL WALL CONSTRUCTION.

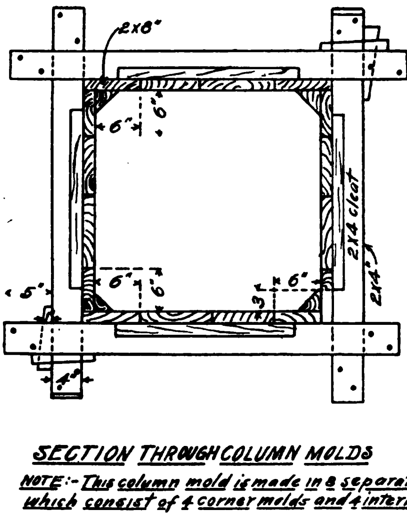


FIG. 11.—TYPICAL FORMS IN BUILDING CONSTRUCTION.

the sides of the beam forms against the bottom board Mr. Cummings uses a 2 x 4 inch runner with wedges against it. The column form shown in the same figure is provided with wedges which permit very firm and solid construction.

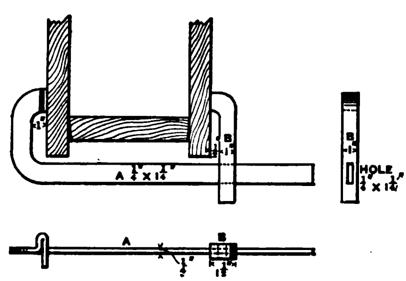


FIG. 12.—CLAMP FOR BEAM OF SMALL COLUMN FORM.

A clamp which is much used by the Ferro-Concrete Construction Company, of Cincinnati, is shown in Fig. 12.

A somewhat different type of beam and slab forms has been designed by Mr. Benjamin Fox, of Boston. The forms for

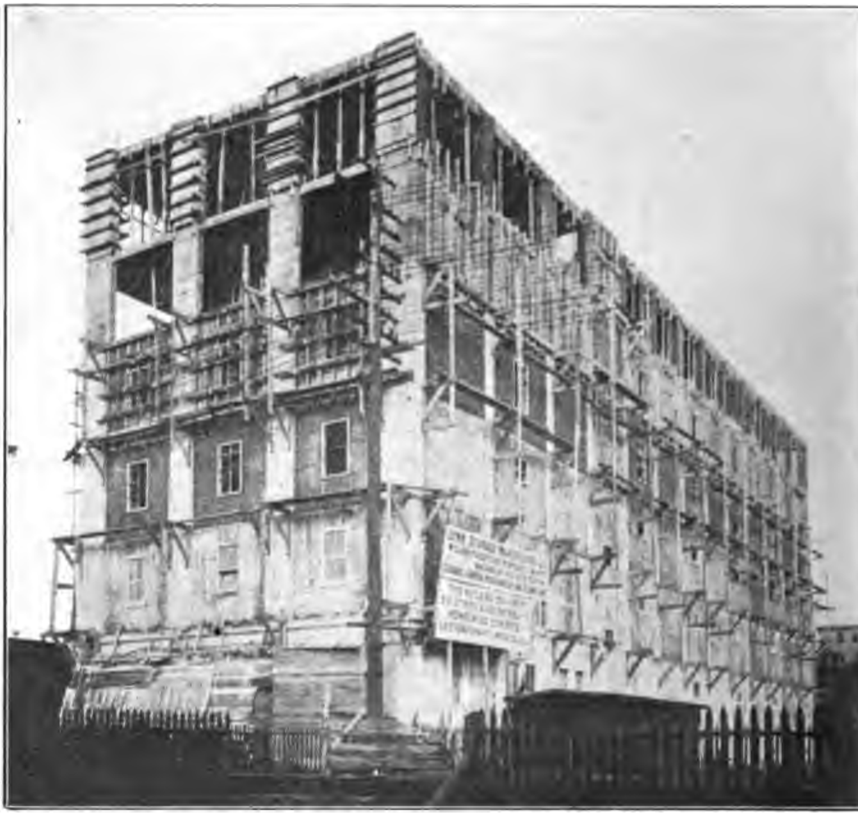


FIG. 13.—PANEL FORM CONSTRUCTION IN STORAGE WAREHOUSE, LYNN, MASS.

each panel are made in two sections and supported at the center so that they may be dropped without disturbing the bottom plank of the beams and girders. The beams and girders are stiffened by 6 x 8 x 8 inch timbers placed underneath them and supported by posts varying in size from 4 x 4 inch to 8 x 8 inch, according to the load to be carried.

Wall panels in a concrete building are most cheaply constructed after the columns are built. Practical methods as adopted by the Eastern Expanded Metal Company, of Boston, are shown in Fig. 13. It also shows quite clearly the other portions of the form construction.

Fig. 14 is a photograph of the pouring of a slab in a sand mold at the Harvard Stadium by methods adopted by the builders, The Aberthaw Construction Company.

FIG. 14.—POURING SEAT SLAB OF HARVARD STADIUM.

Figures 4, 5, 6, 7, 8, 12 and 14 reproduced by permission from Taylor and Thompson's "Concrete, Plain and Reinforced."

Figures 1, 2, 3, 9, 10, 11, and 13 loaned by the Association of American Portland Cement Manufacturers.

DISCUSSION.

Mr. Wiselogel.—I would like to bring up the question of the advisability of placing concrete in freezing weather. I have placed concrete for the foundations of a dry kiln, in boiler foundations and in the walls of a two-story concrete building in a temperature that caused the water to freeze in the hose. I used no salt, did not heat any of the material and made no attempt to prevent the concrete freezing in the forms. In fact it froze so rapidly that it was difficult to spade it in place quickly enough. After it had been placed for some time the temperature rose and a large quantity of water ran out of the concrete. The weather stayed warm for some time after that. This building has given no trouble as a consequence of frozen concrete.

Mr. Caldwell.—It is simply a matter of luck. Whenever you make concrete in a rough state, if it remains frozen up to a certain time and thaws out gradually no harm is done, but if it freezes and thaws alternately it is bound to disintegrate.

Mr. R. Schultz.—On Eighteenth and Washington Avenue, St. Louis, a building is in course of erection. The floor was placed in freezing weather, and a few days ago a section of the twelfth floor, twelve by twenty, fell through all intervening floors to the basement. That is one effect of freezing concrete.

Mr. Cadwell.—I will give you my experience with frozen concrete. I built some floors with expanded metal construction and three inches of cinder and three inches of gravel concrete, in a large seven-story building. Those floors froze up every night as they were put in. About Christmas time there was a terrific sleet storm, and the great excess load for which the centering was not proportioned caused a deflection of two and one-quarter inches in a thirteen-foot floor. The roof was braced up, the building completed and heat put in. Three months later 10,000 pounds was concentrated on eight square feet in the center of one of these panels and gave a deflection under load of one-eighth inch. There was no visible permanent deflection.

On a night of a severe frost I have intentionally left about thirty or forty feet of a walk uncovered in order to see whether this exposed portion of the walk would be affected in any way. It froze so hard that we could not touch that work for four or five days, and then thawed. The exposed portion of that walk is to-day just as good as that which was covered.

MR. F. A. KERCHAW.—I think from what experience I have had it depends a little on how soon a concrete freezes. If a concrete is allowed to get its initial set before it freezes there is very little damage done afterwards, but if the freezing takes place before the cement gets its initial setting, you will find, at least I have found, damage.

MR. E. N. BARKER.—Mr. Wiselogel's building stood probably for the reason that during the first thaw it staid warm long enough for the concrete to set. That is, however, taking a great risk, for in another case a sudden freeze after the thaw might have caused the failure of the building. I would like to ask Mr. Wiselogel how he succeeded in mixing his concrete in cold weather with cold materials. It has been my experience that it has been necessary to heat the sand and gravel and use hot water to get the frost out of the material in order to get any sort of a mixture that is satisfactory. He must have been favored with a very dry material. Is that the case?

MR. WISELOGEL.—The gravel was not frozen very much, but it was freezing all the time. We used, however, much more cement than we usually do.

THE PRESIDENT.—After listening to the remarks of the various gentlemen, the Chair is inclined to believe that the days of miracles have not passed, and he wishes to say that if any gentleman who has heard the statements made wishes to invite trouble he should mix his concrete cold, using cold or frosty materials, in cold weather and let it freeze. The chances will be very strongly in favor of a disastrous failure. The reason for adding water to a material like powdered cement is simply to provide a vehicle by which crystalline compounds can form, which give strength and hardness to that material. Now, when you freeze or convert into ice the water, which is necessary in order that these compounds may form, you are taking away the

very means by which the desired change takes place. Now, there is absolutely nothing that will hold your material together if these compounds are not formed.

If you can heat your materials and let the concrete get its initial set before freezing, you may have no trouble. In the general climate of this country the water used in the concrete may freeze and it may then thaw and the damage that is done to the concrete is due to the disruptive force which takes place when water changes from its liquid to its solid form, and *vice versa,* and the alternate freezing and thawing will break your concrete up just as sure as the sun will rise to-morrow morning. It is bad policy to lay concrete in winter weather. When you are obliged to, you must take every precaution that is known to prevent the concrete from freezing in order that the combinations may take place, which are so necessary in the development of the strength of the material.

The reason the structures mentioned are still standing is due to exceptional conditions and causes which do not appear, and the chance of a condition such as described being experienced generally is extremely doubtful, and to take it would probably lead to collapses of structures all over the country. It is heresy to make general statements of this character based on a few rare exceptions to the general rule. The chair speaks strongly on this point because he feels strongly on it. This organization is for the purpose of teaching people how to do, and the chair, as long as he is in this organization, is going to use his influence to prevent the dissemination of information that is hurtful and dangerous to the proper use of a very delicate material.

MR. LARNED.—I would like to emphasize my confirmation of the statements of Mr. Humphrey, because while we may find a few examples of successful work under such conditions as described here, they are exceptions, and no two parallel cases can be found. A structure built under similar conditions, or apparently similar conditions, in another locality, might fall, and certainly could be expected to fall. It is obviously necessary to prevent cement work from freezing. The whole theory, as you have described it, in my judgment is correct. If you arrest the process of crystalization by freezing, thereby converting the

water which is necessary to crystallization into ice, the process of hardening is arrested. If that is repeated consecutively for a number of times, it successfully breaks the set of the cement. On the first thaw it may start to set again, then if it freezes and is again broken it still further weakens the cement. Now, if that is repeated a sufficient number of times it actually destroys the cement and there is no hope of its recovering. Those things have to be taken into consideration when you work in winter time. Do not attempt to use cold materials, nor materials in which there is frost, and be careful at all times to prevent your work from freezing. That is the only safeguard you can employ and expect satisfactory results.

TOPICAL DISCUSSION ON THE MANUFACTURE OF CONCRETE BLOCKS.

MR. M. S. DANIELS.—Can you add an aggregate which increases your output without a reduction in strength?

MR. C. F. O'NEIL.—I use gravel and sand mixed in the manufacture of blocks. I believe that where there is cement enough to come thoroughly in contact with the several aggregates a perfect block is obtained. The gravel concrete block will harden more rapidly than the mortar block and requires less cement. Since gravel from a pit is not perfectly graded it is necessary for the manufacturer to see that the voids are filled in order to obtain a waterproof block.

MR. JOHN EARLY.—Has anyone had any experience with the Joplin flint? For sidewalk work I am using a tailing or screening that comes from the zinc mines. Much of this material will pass through a No. 6 sieve, and is so graded that a 1-3-4 concrete will give about the greatest density. We can obtain any quantity of this material at $1.40 per ton laid down. Is it as economical to use this material with sand as it is with sand alone with cement at $2.60 a barrel?

MR. D. M. CLICK.—I have had some experience with Joplin flint, but I do not see any economy in its use. I have tested it for fire, and it does not disintegrate in fire. I have used a great many carloads, and I do not think it is a rock that cement will stick to very readily. I notice that quite often it pits out with a good deal of cement to it, both in sidewalks and also in blocks. I have used a 1 : 2 mortar without any sand, and even at that it does not seem to wear a good, smooth surface. It seems to pit to some extent.

MR. O. G. CHANDLER.—I am interested in the block business, and I would like to know why some blocks are white and some dark? We make piece blocks of washed hard limestone screenings some of which are dark, while others are light colored in places. We use a 1 : 4 backing and a facing of 1 : 1½. All the mixing is done by hand, the same size batch always receiving the same number of turns.

MR. O'NEIL.—A possible explanation of this discoloration might be found in the lack of uniformity of sand as it comes from a pit. I believe river sand will always give better results.

I wish also to speak of another matter. It has often been stated to me that it is impossible to put a facing on a block that will stay on under pressure. In my blocks I use a 1:5 gravel backing and 1:2 fine sand facing. I have had a number of these blocks tested in compression and in no case has there been any separation of the facing from the backing.

MR. J. A. GALE.—It has been my experience that the dampness of blocks makes a difference in the color. If the batch is wet it is lighter. The drier it is the darker it is, and if the batch lies on the floor any length of time after being mixed I find it makes a darker block.

MR. E. E. BENNER.—That is also my experience. If I were making batch blocks, and something would happen that would cause some of my mixture to lie on the floor a little bit longer, or a little bit too long, the blocks that were made last out of the same mixture would always be darker than the ones made first.

MR. CHANDLER.—I understand, then, that if the batch lies on the floor too long it will make a darker colored block? We do not allow our facing material to be used until after it has been mixed an hour. But still, we occasionally have a block that is light colored, which does not look well in the wall.

MR. L. E. PORTER.—I have had a similar trouble with my blocks. Out of the same batch I have obtained blocks that were snow white and others of a uniformly pleasing color. By carefully observing the blocks for some time I found that if a block is left on the plate, and does not get water in about the first seven or eight hours, it is liable to get white. I have noticed that the blocks that are watered have a pretty color wherever they have been touched by water, but are otherwise snow white. Whether this is generally true I do not know. The color, whether light or dark, is, so far as I know, permanent. All our blocks are molded with the face down, and are turned down with the face on the side, thus exposing the face to the air. Waterproofing will, I believe, prevent this discoloration, but it is too costly.

MR. PARSONS.—I have found that when left too long on the plate with the face down the color will change, even though

waterproofing is used. The rock face block, in which the face is exposed, I have found to give a uniformly even color, and particularly so when about one per cent of waterproofing is used in the facing material, which was either limestone or sand. Our facing is a 1 : 2 mixture, and we add 1 pound of waterproofing to 100 pounds of cement. This has, I believe, prevented efflorescence in our case.

MR. P. F. CONNELLY.—I have found that the use of waterproofing will give uniformly-colored blocks.

MR. M. S. DANIELS.—Mr. Chandler, do you know whether your materials were always in the same state of dryness? Did you use the same amount of water in every case?

MR. D. G. CHANDLER.—We are, I believe, always careful in adding the water.

MR. C. F. O'NEIL.—I do not think it is necessary to use a certain quantity of water each time, for sometimes the sand and gravel will be dry and sometimes damp, thus requiring a different amount of water for the same consistency. I have had very little trouble due to a difference in the color of the blocks, and I do not use waterproofing. This non-uniformity may possibly be due to imperfect mixing of the facing material. Some portions of that facing may have more cement than other portions, and that being a fact, there undoubtedly would be a difference in the color of the blocks.

MR. DANIELS.—I would like to bring up what I consider a very important matter, and that is the various methods used in arriving at the proper proportions for a given material. What determines the amount of cement and the ratio of the fine to the coarse aggregate.

MR. WM. S. HOTCHKISS.—I determine the correct proportions for my material by trial. I fill a large measure with my coarsest aggregate and then add in succession smaller and smaller-sized material till the voids are reduced to the minimum practical amounts. I find that I can reduce the voids to about twenty-five per cent, and this determines the amount of cement to be used with that particular material.

MR. J. A. GALE.—I use a box. I place my material in the box, and measure the water necessary to fill the voids in the

aggregate. This gives me the amount of cement I must use with the aggregate.

MR. FRED. FISHER.—I have had considerable experience in getting the voids in an aggregate, and I have found that the easiest way is to have a measure of some definite cubic contents, and assume that gravel weighs 160 pounds to the cubic foot, if it were absolutely solid. Then dry your aggregate, which can be easily done, and fill your box even full, and weigh it, and what percentage that is of 160 (assuming that you are using a cubic foot measure) would give you the voids very quickly and much more accurately than you can measure in water, because in pouring in water it is a somewhat indefinite matter whether it will soak the corners of the box full.

I believe that the block machine makers throughout the country have been making a bad mistake in saying that everybody can make blocks without previous experience and from any material that may be at hand. The excellence of a concrete block depends entirely upon the knowledge of the manufacturer.

Any man can take cement and aggregate and mix them together and make a block, but how few know how much water is required to carry that block to the initial set so as to ensure the chemical action which is the vital part of the cement? The cement manufacturers adopted as a standard about 240 minutes of initial action. During that time a chemical action takes place, and the cement in the concrete crystallizes. If that is prevented the greatest strength of our block is lost at that point. It requires over ten per cent water to carry and keep initial action of the chemicals through the 240 minutes. For illustration, five per cent water carries the aggregate with water 150 minutes; seven per cent, 185 minutes; and eight per cent about 215 minutes; nine per cent will reach 240 minutes. If the concrete or mortar is not sufficiently wet to carry it through this first period, a poor block is obtained. Not only is it necessary to have sufficient water in the concrete, but it should also be thoroughly rammed, since by ramming the density, and therefore the strength, is increased.

In regard to the proportion, I differ with a great many. I think too much cement has been used. Too little attention has

been paid to the averaging and gauging of the aggregate so as to fill voids. I believe that it is necessary to use a very fine crushed stone, or, rather, a stone dust, and very nice sand, sharp, clean, and then a real aggregate, and combining those in such a form as to fill the void with as small a quantity of cement as you can. I have obtained the best results by using a damp stone, crushed, we will say, and passed through a three-quarter inch screen. Spread this and place the cement on top and mix the two together. Then put your finer aggregate, gauged as it should be, to fill the void on top of that and mix again. Then apply your water. In doing this you have allowed the cement to coat over the aggregate very slightly, so all of the cement will adhere to the crushed stone. This method gives, I believe, excellent concrete.

MR. J. A. GALE.—I would like to ask Mr. Fisher if he makes a dry or medium wet block, how he measures the ten per cent of water which he says is necessary to keep a block damp until initial set takes place. Is there a method of doing it commercially?

MR. FRED. FISHER.—It is a hard matter for the average manufacturer of blocks to gauge and weigh all of his aggregate. It is unnecessary. A man after he has mixed a few batches of concrete can easily determine the correct amount of water by taking the concrete in his hand. If it will adhere to his hand and leave it wet, and at the same time, by sufficient ramming, water flushes to the surface of the blocks, the correct consistency is obtained. That will give anywhere between eleven and fourteen per cent of water in your concrete.

MR. C. T. O'NEIL.—I think one of the main reasons for so many poor blocks is the fact that so many people do not study the material they are using. A block is a block to the masses of the people, and this attitude is very much against a man who is careful in making his blocks and using the proper kinds of cement and the proper amount. The tendency, it seems, is for cheapness. Questions are very seldom asked whether you can build a better building out of this material for a certain price, but can you build it as cheaply as you can with some other material? The people will have to be educated in the right

direction, and they will become educated much more rapidly, providing the block makers are careful in making their blocks. Where poor blocks are made and buildings fail, it is very much against the practical block maker, but it certainly does not do away with the efficiency of a good block.

MR. L. L. BINGHAM.—Has any one had experience in curing blocks with steam?

MR. N. H. BATTJES.—I have done steam curing for the past two years. We have a long steam kiln into which the blocks are run on a car. They remain in the kiln for forty-eight hours, and from there are run into the yard. The cars hold fifty-six blocks, and are run into a kiln from one-half to three-fourths of an hour, after making the first block on the car. We use a bank gravel running from one-half inch down as our aggregate and are obtaining blocks of almost uniform color. There is no pressure in the kiln. The steam is simply exhausted into the kiln from an engine, which is run only during the day and is only intended to supply moisture to the blocks. The temperature is never high.

MR. HOTCHKISS.—I believe Mr. Battjes makes a mistake when he says he is curing by steam. The method he is using is an excellent way of curing concrete, but I would call it curing with moist air, but not with steam. I believe, however, that steam will cure it just as well and much quicker. I have seen some blocks, however, that were cured by steam which would fall to pieces when handled.

MR. E. S. LARNED.—I think that statement that live steam will surely cure a cement block should be challenged. We are all looking for information here, and it is quite likely that the gentleman has had an experience that justifies that remark, but was it the steam that was at fault, or was it the cement blocks that were at fault? You all know that in testing cement products they are subjected to what we call the accelerated test. That means steam. In some cases it means boiling water; and it is a pretty strenuous treatment, and a first-class sand cement will stand that treatment and be harder than if cured in cold water. The New York Subway Commission have carried on perhaps the most extensive series of cement tests ever under-

taken on a large amount of cement, about one millon and a half barrels, and they have a specific requirement that briquettes should show a certain tensile strength tested under normal conditions, and that a certain proportion of the briquettes should be boiled or subjected to the accelerated test, after which they should be of a certain specified strength, which was less than that of a normal briquette. As a matter of fact, it gave a better test than the normal test gave.

The process as described by Mr. Battjes I think could very properly be called steam curing. It is not the curing that lime-sand product is subjected to. That is curing under pressure. This is not curing under pressure, but still it is curing in the presence of steam.

MR. R. W. RUSSELL.—I would like to ask Mr. Battjes how soon after removal from the kiln it is safe to use the blocks.

MR. N. H. BATTJES.—We use our blocks from six to fifteen or twenty days after leaving the kiln, depending on the speed at which they are needed. We have taken the blocks from the kiln at forty-eight hours and put them in the tubes. They are quite soft at that time, and have to be handled with considerable care. For our concrete we are using a mixture of one part cement to five parts aggregate, of which about forty per cent will pass a one-fourth inch sieve.

SELECTING THE PROPORTIONS FOR CONCRETE.

By William B. Fuller, M.Am.Soc.C.E.*

The growing use of concrete for structures in which great care must be taken to have only the best material and workmanship, has stimulated investigations into the effect of varying the relative proportions of sand and stone in the mix, the proportion of cement to the total remaining the same, and as a result it has been demonstrated very conclusively that the proper grading and relative proportion of the ingredients has a great influence on the quality of the concrete produced. To demonstrate this great effect, the writer at one time made up a set of beams six inches square and six feet long, varying these relations very widely from almost all stone to almost all sand, and broke the beams after thirty days with the following results:

Proportions.	Modulus of Rupture Lbs. sq. in.
1 : 2 : 6	319
1 : 3 : 5	285
1 : 4 : 4	209
1 : 5 : 3	151
1 : 6 : 2	102
1 : 8 : 0	41

By inspecting the above table it is seen that although the amount of cement in each of the above beams was the same (namely, 1-9 of the total material), some of the beams were over 700 per cent stronger than others.

In investigating this subject over a term of years, it has been found that there is one combination of any given sand and stone which with a given percentage of cement makes the strongest concrete, and this is the proportion which also gives the densest concrete, that is, the concrete which contains the least percentage of voids, or otherwise, that which weighs most per cubic foot.

*Consulting Civil Engineer, 170 Broadway, New York City.

It is found also that this dense concrete is least permeable to water and consequently is the most durable, and it is also found that as a practical advantage such concrete is most easy to place, working "slick" and filing up all voids and bad corners.

The above stated law that the densest concrete is also the strongest gives a very easy way of proportioning the materials at hand so as to obtain the best and strongest concrete possible with these given materials. That is, to obtain these proportions by trial, as follows:

Procure a piece of steel pipe eight to twelve inches in diameter and about a foot long and close off one end, also obtain an accurate weighing scale. Weigh out any proportions selected at random, of cement, sand and stone, and of such quantity as will fill the pipe about three-quarters full, and mix thoroughly with water on an impervious platform, such as a sheet of iron; then, standing the pipe on end, put all the concrete in the pipe, tamping it thoroughly, and when all is in measure and record the depth of the concrete in the pipe. Now throw this concrete away, clean the pipe and tools and make up another batch with the total weight of cement, sand and stone the same as before, but with the proportions of the sand to the stone slightly different. Mix and place as before and measure and record the depth in the pipe, and if the depth in the pipe is less and the concrete still looks nice and works well, this is a better mixture than the first. Continue trying in this way until the proportion has been found which will give the least depth in the pipe. This simply shows that the same amount of material is being compacted into a smaller space and that consequently the concrete is more dense. Of course, exactly similar materials must be used as are to be used on the work, and after having in this way decided on the proportions to be used on the work it is desirable to make such trials several times while the work is in progress, to be sure there is no great change in materials, or, if there is any change, to determine the corresponding change in the proportions.

The above described method of obtaining proportions does not take very much time, is not difficult, and a little trouble

taken in this way will often be productive of very important results over the guess method of deciding proportions so universally prevalent. I have repeatedly known concrete to be increased in strength fully 100 per cent by simply changing the proportions of sand to stone as indicated by the above method and not changing the amount of cement used in the least.

A person interested in this method of proportioning will find on trial that other sands and stones available in the vicinity will give other depths in the pipe, and it is probable that by looking around and obtaining the best available materials the strength of the concrete obtainable will be very materially increased.

As a guide to obtaining the best concrete, the proportion of cement remaining the same, the following are the results of extensive tests:

The stone should all be of one size, or should be evenly graded from fine to coarse, as an excessive amount of the fine or middle sizes is very harmful to strength.

All of the fine material smaller in diameter than one-tenth of the diameter of the largest stone should be screened out from the stone.

The diameter of the largest grains of sand should not exceed one-tenth of the diameter of the largest stone.

The coarser the stone used the coarser the sand must be, and the stronger, more dense and watertight the properly proportioned work becomes.

When small stones only are used the sand must be fine and a larger proportion of cement must be used to obtain equal strength.

DISCUSSION.

Mr. F. M. Hunter.—In the erection of buildings we are sometimes so situated that we cannot get crushed stone. Now, it would appear from these tests that a lintel or other beam would be comparatively weak if made of sand or small gravel. In that case, would it not be possible to find the amount of cement that would be necessary to fill the voids in whatever material we might have available, and then add an amount of cement in excess of that and obtain a beam that is satisfactory?

President Humphrey.—Whether sand or stone or gravel should be used is a problem that must be decided by the local conditions. You can bring good material from a limited distance, but if the haul is so great that it will materially add to the cost of the work, you must use what material you have at hand. By putting in a large quantity of cement a beam made of sand may be made stronger than one made of concrete; the advantage of using concrete is one of economy, cheapness. It must not be assumed that because only crushed stone is used in these tests that gravel is not as good. A parallel series of tests with gravel could have been carried on, but the tests as made simply show how varying proportions give different results.

The methods advocated in this paper give the same information as the void test. They tell you how much cement should be added to your sand, or stone or gravel, or by varying the grading of the aggregate they will indicate the combination of sizes that will give the least volume in the cylinder and, therefore, the greatest density and the greatest strength. From those tests then it is for you to determine whether you should use a 1 : 5, a 1 : 3 or a 1 : 4 to get the best results.

A great deal of uncertainty naturally exists in the minds of people who are called upon to build structures in which mortar or concrete is used, to determine how they shall use the material that is at hand, and I think most of you get your ideas from results of practical experience. That is, you try dif-

ferent mixtures, and you find one eventually that you think gives you the best results. Arbitrary proportions are scarcely ever economical. Oftentimes, a relatively rich mixture, that is, one that in point of proportion appears rich, will give much poorer results than one which appears lean. This very test here is illustrative of that point. Here was a material with six parts of stone which give greater strength than one with five, although the relation between the cement and the other aggregate was the same, 1 to 9. It is necessary to have some practical way of determining just what strength you can get. The rule as given in this paper states that the denser the concrete the stronger the mass. Of course, that is modified; there are exceptions to all rules, by any impurities in the materials that go into the mass, or any deficiency in the material which binds it together. But, all other conditions being the same, that is a safe rule. Therefore, as a practical proposition to determine what mixture gives you the densest concrete is practically determining which gives you strongest concrete.

REPORT OF COMMITTEE ON TESTING OF CEMENT AND CEMENT PRODUCTS.

E. S. Larned, C.E., *Chairman.*

The section of this association having in charge the subject of "Testing of Cement and Cement Products" is of the unanimous opinion that the Association should adopt prompt, progressive and aggressive measures to encourage, protect and promote the more intelligent use of cement in all forms of construction.

This organization has, even during its brief existence, assumed national importance and in the breadth and scope of its work can be and should be of even greater benefit to the professions, building trades, manufacturers, resident owners and all others interested in public or private projects in which cement plays a part.

The advantages of standardization and classification are well known, and while it may not be possible, in the rapid development of this industry, to fix at this time rigid specifications covering all the ramifications of our work, yet we must recognize certain fundamental principles that are now well established governing the action of cement under different conditions of use, and should establish requirements that will prevent its misuse and abuse.

For the proper and successful development of the cement industry it is necessary to create universal confidence in its use and avoid the deterring influence of failures of whatever cause. To this end we must educate not only ourselves, but others, and the value of training and experience cannot be overestimated. The public demand for cement construction cannot be met to-day because of lack, not only of contractors and men experienced in this work, but of architects and engineers as well.

Recommendations.

1. *Reinforced Concrete.*—The joint committee of the American Society of Civil Engineers, American Society of Testing

Materials, American Railway Engineering and Maintenance of Way Association and Association of American Portland Cement Manufacturers, have the question of standard requirements and tests of this form of construction under advisement at this time, and we recommend that this organization await the report of this joint committee before taking action upon this most important branch of the cement industry. In advance of this report, however, we do recommend that it be declared the sense of this organization that all cement used in reinforced concrete construction should be high grade Portland cement, meeting all the requirements and tests of the American Society for Testing Materials, and, further, that all cement for such uses shall be tested by a competent person at the works or immediately upon delivery by the railroad, and accepted or rejected in advance of its use or incorporation with other materials.

2. We recommend the appointment of a specification committee, consisting of the President of this Association, ex-officio, the Vice-President and members of the section on "Testing Cement and Cement Products," and the Vice-Presidents of each of the following named sections, viz: Concrete Blocks and Cement Products; Streets, Sidewalks and Floors; Reinforced Concrete; Art and Architecture; Machinery for Cement Users; Fireproofing and Insurance; Laws and Ordinances. The above committee to meet and organize before the close of this convention and a copy of their report and recommendations to be prepared and sent to each member of this association on or before the first day of June, 1907, for consideration in advance of the next annual convention.

3. *Cement Building Blocks.*—No other department of the cement industry has so felt the need of standard specifications and uniform instruction as we find in the manufacture of cement blocks. There is to-day a large and growing demand for this material, and its general and almost unlimited use is only retarded by lack of confidence on the part of builders and resident owners who see only the wretched results that often attend the efforts of the misinformed and inexperienced and overlook the splendid possibilities of this construction in the hands of skilled and experienced operators.

In advance of a standard specification to be adopted by this Association, we beg to emphasize herein a few points and urge their adoption at this time as the sense of the Association.

3(*a*). *Cement.*—Only a true, high-grade Portland cement, meeting the requirements and tests of the standard specifications of the American Society for Testing Materials shall be used in the manufacture of cement blocks for building construction. (We recommend a reprint of the standard specifications in the published proceedings of this convention.)

3(*b*). *Unit of Measurement.*—The barrel of Portland cement shall weigh 380 pounds net, either in barrels or subdivisions thereof, made up of cloth or paper bags, and a cubic foot of cement, packed as received from the manufacturer, shall be called 100 pounds or the equivalent of 3.8 cubic feet per barrel. Cement shall be gauged or measured either in the original package as received from the manufacturer or may be weighed and so proportioned, but under no circumstances shall it be measured loose in bulk or for the reason that when so measured it increases in volume from 20 to 33 per cent, resulting in a deficiency of cement.

3(*c*). *Proportions.*—Owing to the different values of natural sand or fine crusher screenings for use in mortar mixtures, characteristics, it is difficult to do more in a general specification than fix the maximum proportions of good sand that may be added to cement.

3(*d*). Sand, or the fine aggregate, shall be suitable siliceous material passing the one-fourth inch mesh sieve and containing not over ten per cent of clean, unobjectionable material passing the No. 100 sieve. A marked difference will be found in the value of different sands for use in cement mortar. This is influenced by the form, size and relative roughness of the surface of the sand grains, and the impurities, if any, contained. Only clean, sharp and gritty sand, graduated in size from fine to coarse and free from impurities can be depended upon for the best results. Soil, earth, clay and fine "dead" sand are injurious to sand, and at times extremely dangerous, particularly in dry or semi-wet mortars, and they also materially retard the hardening of the cement. An unknown or doubtful sand should be care-

fully tested before use to determine its value as a mortar ingredient. Screenings from crushed trap rock, granite, hard limestone and gravel stones are generally better than bank sand, river sand or beach sand in Portland cement mortars (but not so when used with natural cement, unless the very fine material be excluded.)

So-called clean, but very fine, sand has caused much trouble in cement work and should always be avoided, or, if possible to obtain better, the proportion of cement should be increased. Stone screenings and sharp, coarse sand may be mixed with good results, and this mixture offers some advantages, particularly in making sand-cement blocks.

3(*e*). For foundations or superstructure walls exposed to weather, carrying not over five tons per square foot, the maximum proportion shall not exceed four parts sand to one part cement. This proportion, however, requires extreme care in mixing for uniform strength and will not produce water-tight blocks. We recommend for general work not over three parts sand, if well graded, to one part cement, and the further addition of from two to four parts of clean gravel stones passing the three-fourths inch mesh sieve and retained on a one-fourth inch mesh sieve, or clean, screened broken stone of the same size. These proportions, with proper materials and due care in making and curing, will produce blocks capable of offering a resistance to crushing of from 1,500 to 2,500 pounds per square inch at twenty-eight days.

(For the best fireproof qualities limestone screenings, or broken sizes should be excluded, but otherwise they are all right for use.)

Where greater strength is desired, particularly at short periods from two to six weeks, we recommend the proportions of one part cement, two parts sand and from one and one-half to three parts gravel or broken stone of sizes above given. Blocks made of cement, sand and stone are stronger, denser and consequently more waterproof than if made of cement and sand only, and are more economical in the quantity of cement used.

3.(*f*). *Mixing*.—The importance of an intimate and thorough mix cannot be overestimated. The sand and cement should

first be perfectly mixed dry and the water added carefully and slowly in proper proportions and thoroughly worked into and throughout the resultant mortar; the moistened gravel or broken stone may then be added either by spreading same uniformly over the mortar or by spreading the mortar uniformly over the stones, and then the whole mass shall be vigorously mixed together until the coarse aggregate is thoroughly incorporated with and distributed throughout the mortar.

We recommend mechanical mixing whenever possible, but believe in the thorough mixing of cement and sand dry before the addition of water; this insures a better distribution of the cement throughout the sand, particularly for mortar used in machine-made blocks of a semi-wet consistency. For fine materials, such as used in cement blocks, it is necessary that the mechanical mixer be provided with knives, blades or other contrivances to thoroughly break up the mass, vigorously mix the same and prevent balling or caking.

3(*g*). *Curing.*—This is a most important step in the process of manufacture, second only to the proportioning, mixing and molding, and if not properly done will result either in great injury to or complete ruin of the blocks. Blocks shall be kept moist by thorough and frequent sprinkling or other suitable methods, under cover, protected from dry heat or wind currents for at least seven days (preferably two weeks). After removal from the curing shed, they shall be handled with extreme care, and at intervals of one or two days shall be thoroughly wet by hose sprinkling or other convenient methods. We recommend curing in an atmosphere thoroughly impregnated with steam. This method serves to supply needed moisture, prevent evaporation, and in some measure accelerates the hardening of the blocks.

We view with distrust, in the present knowledge of the chemistry of cement, any artificial, patented or mysterious methods of effecting the quick hardening of cement blocks or other cement products. If such method be proposed it should be thoroughly investigated by competent authority before use.

a. Time of Curing.—This is also most important in its effect upon the industry, and is directly and vitally influenced by the following conditions:

1. Quality, quantity and setting properties of the cement used.

2. Quality, size and quantity of the sand or fine aggregate used.

3. Amount and temperature of water used.

4. Degree of thoroughness with which the mixture is made.

5. Method of curing, weather conditions and temperature.

6. Density of the block as affected by the method and thoroughness of tamping or pressure applied.

Before fixing the minimum permissible time required in curing blocks, we wish to emphasize the important effect of additions of sand upon the tensile strength of cement mortar. In doing so, we will refer to an experiment made at the Holyoke dam, Mass., to determine the tensile strength at twenty-eight days of a high-grade Portland cement, mixed with different proportions of sand, the briquettes being kept in water (after twenty-four hours) until broken.

TWENTY-EIGHT-DAY TENSILE TEST.

Sand to Cement.	Lbs. per Sq. inch.	Ratio.	Sand to Cement.	Lbs. per Sq. inch.	Ratio.
Neat Cement.	889	100	5 to 1	133	15
1 to 1	805	90	6 to 1	121	14
2 to 1	589	66	7 to 1	71	8
3 to 1	343	39	8 to 1	53	6
4 to 1	204	23	9 to 1	44	5

These great differences would be more marked at periods less than one month, and not quite so marked at longer periods. At twenty-eight days, however, it is apparent that the 4 to 1 mixture has only thirty-five per cent of the strength of a 2 to 1 mixture, and but fifty-nine per cent of the strength of a 3 to 1 mixture, while the 5 to 1 mixture has but thirty-nine per cent of the strength of the 3 to 1 combination, and only sixty-five per cent of the strength of the 4 to 1 mixture, and but twenty-three per cent of the strength of the 2 to 1 mixture. The ratio of compressive strength to tensile strength is not quite constant for all periods of time, and for the several mixtures above given, but the compressive strength or resistance to crushing per square

inch may be approximately obtained by multiplying the tensile strength given in the above table by the constant, six (6). (See remarks.)

Recommendations.—If blocks be made of approved materials and under approved conditions, we recommend the following as the minimum period of time after their manufacture, at or after which the blocks may be used in building construction.

CURING OF BLOCKS.

MORTAR COMPOSITION	TIME REQUIRED FOR CURING BEFORE USE
1 cement to 1 sand	14 days
1 cement to 2 sand	21 days
1 cement to 3 sand	28 days
1 cement to 4 sand	45 days
1 cement to 5 sand	90 days (See note.)

NOTE.—This mixture is not recommended, but is given to show the increase in time required for so lean a mixture to gain the strength required by leading specifications now in force.

We believe it is wrong in principle to fix a uniform period for curing or ageing, without due regard to the proportions used. It is manifestly unfair to require as long a period for a 2 to 1 or a 3 to 1 block as for a 4 to 1 or 5 to 1 block, and it is obviously unsafe to attempt to use a block of lean proportions in as short a time as a rich mixture would gain the necessary strength. This might be supposed to be met by fixing the minimum resistance to crushing of blocks (of all compositions), but it must be kept in mind that a very small percentage of the blocks used are tested, by reason of the expense, inconvenience or lack of facilities or time.

Marking.—All cement blocks shall be stamped (in process of making), showing name of manufacture, date (day, month and year) made and composition or proportions used.

Requirements.—We believe that architects and engineers or builders and other purchasers of blocks should be encouraged to require and give preference to blocks made under the Standard Specifications of the National Association of Cement Users.

Tests.—Blocks may be subjected to any one or all of the following tests, viz: Transverse, compression, absorption, freezing

and fire. These tests should be made in some laboratory of recognized standing, and we recommend uniform instructions for conducting such tests.

We also recommend the use of uniform report cards or forms showing results of tests made.

Licenses.—We recommend the granting of license to intending manufacturers of blocks, said license to be revocable for the following causes, to wit:

1. Wilful violation of specifications, laws and ordinances.

2. Dishonest methods.

3. Use of improper materials, the quality of same, if in question, to be determined in a disinterested laboratory of recognized standing, but also subject to verification, if desired, by either party at issue.

SIDEWALKS AND PAVEMENTS.

Sidewalks and pavements:

We recommend that the National Association of Cement Users urge and encourage in every way feasible the adoption by all municipalities of standard specifications and uniform instructions covering the construction of all pavements and sidewalks in or on public ways, and insist that same be observed, whether the work be done by public or private appropriations.

This provision has special reference to the preparation, depth and character of foundations, curbing and pitch or grade of pavement, also the marking, jointing and quality of materials used in construction. Due attention shall also be given to the protective measures necessary to prevent injury to work, in course of construction or newly completed, by reason of weather conditions, heat and cold, or too early use.

DISCUSSION.

Mr. L. L. Bingham.—Were the grains of the sand used in those tests all of uniform size or did they vary?

Mr. Larned.—The size was the same as that of the standard sand, that is, a sand that passes a 20-inch mesh sieve, and is retained on a 30-inch. A sand of this nature will give good comparative results. If a graduated sand is used for comparative cement tests, the tests are subject to variation, because the sand is not always uniform, but with a uniform sand your results should be uniform, and consequently your comparisons are justified.

Mr. Thompson.—I wish to express my appreciation of this very comprehensive and able specification that has been read. There is one point that I would like to ask the chairman of the committee. I notice that he recommends the steaming of concrete blocks, and I would like to ask if he can refer me to any definite test which determines one way or the other that the steam test is of special advantage.

Mr. E. S. Larned.—No specific test, Mr. Thompson, other than the test of actual use. I know, as a matter of fact, that blocks so cured are harder, more perfect, less subject to injury in handling, and generally of better appearance than blocks cured in the ordinary way. As to whether they show corresponding advantages in the matter of compression or not, I do not know, but I think it would be perfectly fair to assume that with the other advantages no doubt they would.

President Humphrey.—From the results of some of the experiments at St. Louis, I would state that there are advantages and disadvantages, or there are advantages and dangers, connected with the steaming of concrete blocks. If a block is made in a machine and placed within, say, three or four hours, or almost immediately, in a steam chamber in which steam is turned in under pressure, the temperature of that room will rise, and with the increase in temperature the moisture will be converted

into steam and the hardening of the blocks checked. The blocks, under those conditions, will be materially weaker.

If, on the other hand, the block is made up in the ordinary way and allowed to stay under moist conditions, sprinkled and then placed in a steam chamber, the heat will accelerate the process of hardening, and the block will come out in a condition in which it can be handled much more quickly because of these more rapid chemical reactions than would be the case under ordinary conditions.

MR. J. R. GILL.—I would like to have an explanation of a certain experiment which I will describe. I made a lot of blocks of a sloppy wet mixture, and two or three hours after molding put them into a steam curing chamber into which exhaust steam was led. They were permitted to remain in this chamber for two days, and when taken out were all of a chalky nature. I noticed this peculiarity a number of times, and in one case the strength of the cement seemed to be almost entirely destroyed.

PRESIDENT HUMPHREY.—That is not surprising, because the probability is that the air from the chamber absorbed the water from the blocks and interrupted or stopped entirely the process of hardening, and the chalky condition was the direct result of that.

MR. F. M. MARTIN.—How long should a block be dampened before it is put in the steam chamber? As I understand you, Mr. Humphrey, you recommend sprinkling them once or twice before they are placed in the chamber?

PRESIDENT HUMPHREY.—Perhaps I was misunderstood; I do not think I recommended,—I stated that that was one of the ways in which the blocks could be handled. If you keep the room in which the blocks are stored at normal temperature, say 60 degrees, then I presume that in the course of five or six hours the block would stand placing in a moist atmosphere in which the temperature could be 70, or a little in excess of 70, degrees. If, on the other hand, you place your blocks out in the open air where the temperature is down to 40, the rate of hardening of the cement would be materially less, and you might have to keep them damp for a longer period.

MR. WILLIAM S. HOTCHKISS.—Mr. Larned, is there any objection, where you are working in a bank of gravel, to use a

large aggregate, say, up to an inch and a half, where the thickness of the wall warrants the use of a large block.

MR. E. S. LARNED.—I should say unhesitatingly no. The one danger and disadvantage of using a bank gravel is this, that the proportions of sand and stone are not uniform. That is obvious to anyone who has ever attempted to use bank gravel. As a rule, the material is taken from the face of the excavation. If that face is six, eight or ten feet high, any man who has ever worked in a borrow pit knows that when it is picked down the stone goes to the bottom. In other words, there is a sort of mechanical separation, a sort of gravity screen. When you load this material you are going to get alternate loads of sand and of stone. There is only one way to get uniform results, and that is to gauge your material uniformly.

The amount of dust in crushed stone depends on about four factors: First, the size and character of the stone crusher; second, the rate of feed in the hopper; third, the speed of the crusher; fourth, the moisture in the stone. I think you will all appreciate these practical conditions. After crushing, the stone is usually elevated to a bin where at least the tailings are screened out, even if there is no intention of separating the intermediate sizes. What happens? The fine stuff drops directly under the trap of the elevator. Then follows at regular intervals the other sizes, and the coarse stuff goes to the end of the bin.

You draw it from your bin and then what happens? You know that the action of friction is so different in different sized materials that when you begin to draw the stone from your bin the coarse stuff runs out first. The bin is not always full, and you may be working sometimes where the material has worked back to the side of the bin, consequently you get alternate loads of coarse stuff and of fine stuff.

If the stone is piled instead of being placed in a bin, matters are just as bad. The coarse stuff rolls down just as it does in the bin. You cannot get the run of the crusher unless you put a gauge box right under the crusher, take the stone as it comes out and use it immediately. If you store it, or transfer it, you cannot get crushed run material. The same thing is true of bank gravel. Do not use it in this form. Separate your stone, then gauge that accurately with your sand, and you know what you

are getting every time. You will realize the importance of gauging if you look at these sand tests, in which the strength varies from 343 pounds for a 1:3 mixture to 143 pounds for a 1:5 mixture. It is a very significant fact and accounts for a great many failures in blocks that men do not understand.

MR. J. A. GALE.—I want to try to make up my mind from the opinion of those who have had the experience, whether or not steam curing is better than sprinkling with water in a warm room. It seems to me that that has not been settled definitely.

PRESIDENT HUMPHREY.—I believe the question is unsettled, and will be for some little time. I think the question of steam curing is a commercial proposition. It is a means of rendering your product marketable in a very short time. Unquestionably the best way for concrete to harden is slowly, under damp conditions. The formation of crystals in cement which produces hardness or strength must necessarily be a slow process. It is a known fact in chemistry that heat often accelerates the chemical reaction. Now, when you introduce heat and a dry air at the same time you have two opposing forces, one of which is robbing the material of the water which is absolutely necessary to produce strength, and the other is temperature which if sufficiently high may drive off the water which is already there. The practical condition that must be confronted is to get the temperature at least 70, or possibly a little above, and not have the conditions of your room so that the air is dry and will take the water from the material to which you are trying to give strength. You must keep your air damp and if you do so, then the temperature does not make much difference, because you can probably put these blocks into hot water and get good results.

The hardening can also be accelerated, and it is a process that is commonly employed by introducing a little carbonic acid gas, which forms a hard coating on the block, and enables you to handle it in a shorter time.

A MEMBER.—Would it be practical to place in your steam room an automatic sprinkler or a fine spray to overcome the dryness of the steam heat and by that process force the curing? What we need most in the cement business is to produce a stone properly cured in the shortest possible time in order to meet the requirements. Can we do that by forcing it in that manner?

PRESIDENT HUMPHREY.—I believe that is a most excellent way of correcting the evil.

A MEMBER.—If a block is made sufficiently wet, so that by tamping moisture will appear on the top of the blocks, is it necessary to continue the sprinkling so long? I have had trouble with the face of a wet mixture block checking almost immediately after removing from the machine. Can we make a wet block without checking the facing of the block?

PRESIDENT HUMPHREY.—With a wet process, there is a tendency to bring the neat cement to the surface, and that naturally intensifies the checking action.

MR. SPENCER B. NEWBERRY.—I have seen something of the steam curing of concrete blocks, but all that I know about it has been obtained either from thinking over the subject or seeing what others have accomplished.

There have been several considerations mentioned this morning that seem to me very important. There is a great deal connected with this subject that we do not know, and one of the most important things that we ought to know, and may sometime know, is whether it is a question of time, whether the crystallization of the cement which we know gives it strength, the formation of crystals of hydrated lime—whether that is something that can only be made complete and perfect by very gradual methods.

The whole gain in steam curing is unquestionably the saving of time. It is a commercial proposition, as our President has said, to enable us to put out blocks and get them into the building sooner than we would be able to do if they were allowed to cure spontaneously. Then it is a question whether the cost of the steam plant and the additional handling of the blocks is going to be of sufficient disadvantage to counterbalance the gain that we would have in being able to put out the blocks sooner. I have always taken it for granted that it would not pay to do it, and we find that with briquettes of cement and sand, we can gain in twenty-four hours with steam as great strength, if the cement is perfectly solid, as we can gain in seven days with water under ordinary temperature; in other words, we gain five or six days in time.

With concrete blocks of considerable size, it is probable that the proportional gain would not be nearly as great.

There is another great disadvantage which I think many perhaps have experienced with the sudden changes of temperature which take place when cold blocks are put in hot steam, and then taken out and immediately exposed to cold air. These sudden changes are so great as to produce more or less shrinkage.

At Atlantic City I saw a large number of blocks or slabs of cement which had been cured in steam and afterwards exposed to the air, and nearly all of them showed small cracks on the surface. It is inconceivable that these would have shown such cracking, as they were well made, of normal compounds, if they had been cured spontaneously under ordinary conditions. I can only say that I think this is a matter of great importance upon which we need a great deal of light. Apparently there is much confusion about it.

I judge from what some of the gentlemen said that when they speak of steam curing, they mean curing in a room heated by radiators, but that is not steam curing any more than sticking blocks up against a hot stove is. It is simply a question of warmth. To my idea, steam curing, as we use the term, means putting the blocks in a chamber which is filled with steam, and steam at moderate temperature.

There was one point made by President Humphrey which seemed to me very important, and which had never occurred to me, and that is, that if the steam is of high temperature it will have the effect of drying out the blocks, even though the atmosphere may be full of steam. That is a danger that certainly would have to be avoided, and no doubt the only safe way would be to cure these blocks in a chamber full of free steam at comparatively low temperature, that is, below the boiling point of water. If the steam is free to escape, the temperature would not rise above that point. Even if that is done it seems to me very important that the blocks should be gradually warmed, gradually brought up to temperature and gradually cooled, or I believe fully that shrinkage and cracks on the surface would take place. I am sure the investigations and experiments that are being carried on under Mr. Humphrey's direction at St. Louis will give us very important light on this subject.

THE ARTISTIC TREATMENT OF CONCRETE.

BY A. O. ELZNER.

The consideration of concrete from an æsthetic point of view may strike the average cement user as inappropriate and impossible, for hitherto the term "concrete" at once suggested foundations, piers, dams, abutments, and nowadays it more than likely calls to mind columns, beams, floors, walls, and in fact the entire structural parts of buildings. But it must be evident that our experience with this new material, new only, however, in the sense of adaption, will show that, like all legitimate and substantial structural materials, it, too, will prove to be susceptible of artistic treatment in design. Wood and stone architecture are as old as the hills, and the art of the mediævalist in developing true styles with these humble materials rightfully belongs to the world wonders. Brick and terra cotta can scarcely claim quite so much distinction, although in point of artistic treatment they were brought to high development in the Gothic art of Italy. Iron and steel, however, do not fare quite so well except in a small way along the lines of purely ornamental work; for when the modern rolling mill began to turn out its product of structural shapes, and engineers discovered the wonderful possibilities of riveted sections and connections, there was a great rush for structural iron and later for steel. Everything imaginable was made of it, and more so in Europe than here. Bridges and viaducts, certain classes of business blocks and public buildings, even churches and cathedrals, all vied with one another in their architecture of iron and steel, and while some notable attempts achieved a measure of success, it required many years to develop an artistic style of design. And even at this late day structural engineers as a class seem determined to ignore the application of æsthetic principles to their designs of exposed work.

But we feel quite hopeful. There has been and is much teaching and preaching of æsthetics. Schools, periodicals and

municipal art societies are doing much to educate the popular taste and to create a demand for beauty in public works, and this campaign, whose influence is spreading rapidly, will undoubtedly bring designers to recognize and appreciate the necessity and propriety of combining beauty with utility in all visible constructions.

This problem will be greatly simplified in concrete work, for here for the first time, we come to deal with a plastic material which can be molded and modeled at will. Beauty, however, in structural design is worthy of the name only when, like beauty in nature, it has character. It must not be a survile copy of the style peculiar to some other material, but in fact must express the individuality of its own nature and must not dissemble.

It is just this peculiar that we must be careful of our concrete block architecture. At present the tendency in the manufacture of these blocks is to imitate split faces of stone ashlar. This is radically wrong in principle, and should not be tolerated. A flat, smooth face will always look well. However, if a pitched or split face is desired, let it be produced by casting the block flat and then pitching off the face with chisel and hammer, just as is done with stone. The clean fracture of the concrete thus exposed will be eminently effective and artistic and will have all the merit that belongs to truthfulness. Plain concrete ashlar walls might in some cases be effectively relieved by the introduction of bands of decorated blocks with some simple ornament molded in the face, very much as is done with terra cotta. But by all means avoid molded rock faced work. It is artistically bad. The frequent and constant repetition of a few regular sizes and patterns ruins an effect which should be counted largely as accidental, but always expressive of a fine artistic sense in the selection and grouping of the indiviudal blocks Artificiality, imitation and misrepresentation are stamped all over such work and can be recognized at first glance.

Solid concrete walls have a great advantage over the block walls in that they lend themselves much more readily to artistic treatment.

This is especially true where they are used in suburban and country buildings, perhaps because of the touch of nature in

the surroundings which more nearly accords and harmonizes with the broad treatment that can be so effectively employed in wall surfaces. Perhaps the best sources of inspiration that can be had for such treatment are to be found in the old Spanish missions of California, which, although not of concrete, nevertheless at once suggest its use and, above all, are fine examples of the artistic value of broad wall surfaces relieved by exquisitely proportioned openings judiciously spaced and not infrequently embellished by a moderate use of ornamentation.

Let us say then, speaking of domestic architecture, where walls are made of solid concrete, the surfaces should be as unbroken as possible, avoiding especially artificial jointing, of which such frequent use is made, and is obtained either by scratching a joint into the fresh mortar with which the surface is plastered, or after the removal of the forms, or by planting beveled wood strips on the inner surface of the forms, thereby molding the joint directly into the concrete.

Both methods are highly objectionable, utterly senseless and æsthetically very bad and should be shunned. In work of moderate cost where effects are to be sought in an inexpensive, straightforward and natural way, there can be no offense taken if the concrete is left untouched after removing the forms. In fact, this method has so much merit that it might with perfect propriety be classed as the most thoroughly artistic. That is probably just what the builders of the old Spanish missions would have done if they had had concrete to use for their buildings.

To be sure, if such treatment is to be used, some care should be exercised in the preparation of the form work, so that it will not result in the effect of a lot of patchwork.

In more pretentious work several methods of treating the exposed concrete are available.

A thin skin or crust of neat cement usually is found to cover the surface where concrete was deposited wet and was well tamped. This crust may be removed while still soft by means of a stream of water having some force, or by stiff wire brushes, in which cases the forms must be removed promptly and just as soon as the work will stand it. This, however, in-

volves considerable danger and should be done only by thoroughly experienced persons. If successfully accomplished, the effect of the rough surface thus produced is good and consistent, for it exhibits the material in its true nature and avoids all semblance of artificiality.

This treatment, however, entails so many difficulties that it will not be very popular, and it will be advisable to adopt some other simpler and safer method giving similar results. The surfaces can be tooled all over with a chisel, as in some classes of stone work, but while the result may be effective, it is rather expensive and slow work, and will therefore be but sparingly used. It is difficult, too, to avoid loosening an occasional pebble or stone and thus spotting the surface with objectionable blemishes, and possibly opening up some internal cavities which are quite apt to occur and so starting a leak in the wall.

A simple and inexpensive, yet thoroughly practical method of securing an artistic effect consists of covering the wall surface with a splatter-dash coat of cement mortar applied by splashing it on with a paddle or a broom, or, better still, it may be first spread on with a trowel and then roughened by stippling with a stiff broom or brush or even a flat board, in which case the roughening is obtained by suction against the board. When such treatment as this is to be used it may be highly appropriate in some cases and indeed quite interesting to decorate parts of the surface with some simple panel work or free-hand modeling. In case of panels it is best and simplest to adopt sunken work, as this can be readily produced by merely planting a board or block of desired shape against the inside face of form work which leaves its impress upon being removed from the concrete. Or else a reverse mold made of some artistic bit of carving for a panel, or over a door or window, or a frieze, etc., may be nailed against the forms, and the resulting impress will be thoroughly effective, although a much higher artistic value would be due such work if it were modeled by hand directly in the cement mortar as it is applied and before it has had a chance to harden.

This sort of work is being done extensively and successfully in Germany, where the modern style of "Nouveau Art" presents abundant opportunities for endless designs. It is already

finding much favor in our own country, and ought to reach a high degree of development.

Moldings, especially in continuous courses, if attempted at all, should be of the simplest possible design; bold, yet of moderate projection and free from small, delicate members. Square offsets and beveled projections serve very well in the place of conventional moldings and rather accentuate the character of the work and heighten its effect. Dentils of fair size can be worked in to good advantage and with comparative little difficulty. Such work should, however, be used sparingly on account of the impracticability of treating the surface of the resulting small members, unless great freedom and latitude are allowable without detriment to the artistic character of the design. It is particularly difficult to do this in case the walls are to be plastered over with cement mortar. Where this is done the work should be finished under the float rather than the trowel, so as to minimize the tendency to map crack or craze, a great source of annoyance and disfigurement. Trowel finish, furthermore, almost invariably produces a series of blotches of different shades and textures which, if introduced into rough work, have much artistic value, but must be classed as nothing better than blemished in smooth troweled surfaces. Moreover, it is extremely difficult and well nigh impossible in plastering over moldings or projecting band courses, to keep the edges straight and true as they should be in smooth finish, with the result that the poor, slovenly workmanship imparts an air of cheapness and flimsiness to the building instead of the reverse—value and substance. Such, then, are some of the readier methods that can be employed in producing artistic effects with concrete. This humble material, so replete with possibilities, but as yet so little understood, is manifestly destined to take an important place in the construction of our buildings and must therefore strongly influence their design. But it means long, continuous and close observance and study of its nature, its possibilities and its limitations, and if our designers will devote themselves sufficiently to this subject as it so well deserves, they will discover in concrete a new and useful friend, and with its help will evolve a new architecture that will be full of life and character, strength and dignity and all else that goes to make up a living style.

CONCRETE SURFACES.

By Henry H. Quimby, M.Am.S.C.E.*

The ordinary concrete structure—whether of building blocks or monolithic masonry, and whether as left by the forms or as commonly finished for exposure to view—is anything but pleasing in appearance, and this fact seems to be the principal reason for the disfavor with which some architects and engineers regard concrete as a material for construction.

The blocks usually have a bubbly, artificial-appearing surface subject to a discoloration that is generally of a sickly or lifeless hue, which offends the eye quite apart from the unpleasant effect of the machine like regularity of such blocks as are made in imitation of rock-face ashlar. Monolithic concrete is usually finished either by painting with a thin cement wash or by floating, and it is doubtful whether really satisfactory effects have ever been produced by either of these methods on work that was in the forms long enough to get quite hard. The material that ordinarily segregates against the mold forms a skin that seems to have the quality of making very uncertain the attachment to it of any coating, whether of neat cement paint, or of plaster, and if no coating be applied to it and the skin be not removed, the appearance of the work, particularly after a little aging, can be adequately characterized only in language that is too picturesque for a serious paper.

There is, therefore, an active demand for a means of putting a better front upon a concrete body without overloading it in cost.

It has been suggested that a stucco finish can probably be made to adhere permanently, and it is reported that a plaster coating mixture of lime, cement, and sand, has been tried with gratifying results. A very handsome appearance can undoubtedly be thus obtained, but it is generally unlikely that the

*Engineer of Bridges, City Hall, Philadelphia, Pa.

FIG. 15.—SAND AND YELLOW PEBBLE CONCRETE (NATURAL SIZE).

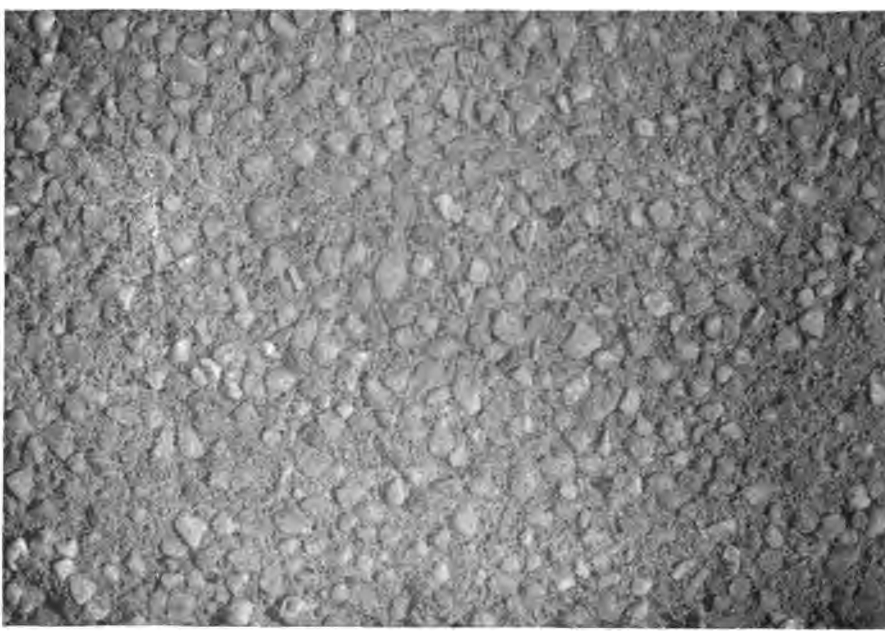


FIG. 16.—WHITE PEBBLE CONCRETE (NATURAL SIZE).

coating will endure wholly intact, and certain that it will not unless the surface be first carefully prepared for it by some such method as treating with acid or by picking it rough, which altogether would make an expensive finish and if portions should loosen and come off the condition would be shabbier than anything else that can be conceived.

The mere roughening, however, of the concrete surface to insure the adhesion of a coating of any sort, will itself, if completely and uniformly done, produce a pleasing and ordinarily satisfactory finish—provided, of course, that the concrete has a complete face fully flushed against the forms.

It follows then that tooling the surface to the extent of removing the film is a practicable and always available method of finishing it, and the tooling can be done with a bush hammer or an axe, by hand or pneumatic power. The tool should be light, and the blows only heavy enough to "scalp" the work, heavy tools and blows being liable to "stun" the concrete, particularly at and near edges. This scalping partially exposes the material of the aggregate but does not clean it. The complete exposure and cleaning will come with time and exposure to the weather if the work be out doors; or the action of the elements can be anticipated by washing the tooled surface with a half-and-half dilution of hydrochloric acid, which of course must be thoroughly rinsed off.

The cost of such tooling, without subsequent cleaning with acid, has been variously found to be from three to twelve cents per square foot according to the character and extent of the work and the equipment.

Experiments upon small blocks have shown that a very expeditious method of removing the skin is grinding with a coarse grained emery or carborundum wheel. The skin is cut about as quickly as the block can well be passed over the wheel, and although no actual comparison has been made and there is no knowledge of a trial of it on large work with a portable wheel, it would seem that with compressed air or electric motor and a flexible shaft, the emery wheel might be used on any work with about the same facility as a power bush hammer, and the rapidity with which the wheel cuts away the face indicates that such a

FIG. 17.—GRANITE GRIT CONCRETE (NATURAL SIZE).
1. Cement. 2. Bar sand. 3. Crushed granite, $\frac{1}{4}''$ size.

FIG. 18.—BLACK SHALE GRIT CONCRETE (NATURAL SIZE).
1. Cement. 2. Sand. 3. Crushed shale, $\frac{1}{4}''$ to $\frac{3}{8}''$ size.

method of tooling will prove to be no more expensive than bush hammering. The wheel might be small in size and therefore of light weight for convenience in handling, and could be fitted with small guide rollers to limit the depth of cutting and secure reasonable evenness in the dressed surface.

Building blocks have been treated, without the preliminary tooling, by immersion for a sufficient length of time in an acid bath strong enough to dissolve the skin and some of the cement mortar between the particles of the aggregate, exposing and cleaning the particles and even leaving them in relief. This process, which is said to have been patented, includes washing after the acid bath, then immersion in an alkali bath to neutralize any absorbed acid remaining, then final washing with water. It is presumably expensive, is of necessity limited in its application to portable work, and care must be taken to avoid using in the concrete any sand or stone that is liable to injury by the acid.

It thus appears that the removal of the film and exposure to view of the clean aggregate, by whatever method obtained, is the essential feature of the most certainly durable and generally satisfactory surface finish of concrete. Of course it should be understood that the surface must be fully flushed—must be without cavities or visible voids between the stones. This condition can only be secured, when pressure cannot be applied, by using wet concrete thoroughly spaded or forked against practically watertight forms, or by using with stiffer concrete a separate mortar or fine concrete applied against the face form with a trowel just in advance of the body concrete. Stiff concrete will not completely flush against the forms by mere ramming, even if the ramming does work it to a liquid on the top of the layer. Care must be exercised with every portion of the face or voids will occur and appear when the forms are removed, and will necessitate patching. Such repairs cannot be made sightly unless at the time they are made the body is still green—before hard set has taken place. If the surface is accessible while still friable, blemishes can easily be removed without leaving a scar.

This fact suggests the desirability of early removal of the forms; and their removal after the concrete has set sufficiently to maintain itself, but before hard set has taken place, furnishes

the opportunity for applying a treatment that is very convenient and inexpensive, yet produces the most pleasing and in all respects most satisfactory finish which has yet become known.

This process consists wholly in scrubbing the fresh surface with a brush and water, thereby removing the film, and with it all impression of the forms, and exposing the clean stone and sand of the concrete. If it be done at the right time—that is, when the

FIG. 19.—CONCRETE BRIDGE ABUTMENT, SCRUBBED SURFACE.

material is at the proper degree of set—merely a few rubs of an ordinary house scrubbing brush with a free flow of water to cut and to rinse clean, constitute all the work and apparatus required. A little additional rubbing will bring the larger particles into appreciable relief, which heightens the effect and, in the judgment of most observers, enhances the beauty of the face.

The practicability of removing the forms at the proper time for such treatment depends upon the character of the structure

and the conditions under which the work must be done. The system cannot be applied to the soffit of an arch nor to the underside of a reinforced concrete floor, because the centering must be left as support so long that the surface against it is almost stone hard. If, however, the surface material there is the same as at the sides

FIG. 20.—CONCRETE ARCH AND PARAPET, SCRUBBED SURFACE.

which have been scrubbed, the soffit can be brought to match the sides by tooling and then cleaning with acid and water as before described.

The texture and color of the surface obtained by this process will vary with the character of the aggregate of the concrete because in a mixture of cement, sand and stone the cement is in small proportionate volume and has but little influence on the color of the ensemble. Some opportunity is thus afforded for the

exercise of individual taste in texture and color, and it is very easy to arrange a quiet color scheme in any work that may be suited to it. Warm tones can be obtained by the use of crushed brick or red gravel. A dark-colored stone with light sand will produce a surface that resembles gray granite. Fine gravel gives an appearance so like sandstone that even close examination will not enable one to distinguish between them. In the construction of monolithic concrete masonry for bridges for the city of Philadelphia it is the practice to use a fine concrete or granolithic face composed of (1) cement, (2) bank sand, and (3) crushed and

FIG. 21.—ROUND CONCRETE BALUSTER FOR BRIDGE RAILING, SCRUBBED SURFACE.

cleaned black slaty shale, of the size commonly used for roofing—say one-fourth inch to three-eighths inch. This mixture is placed against the face forms and the body concrete is placed against it and rammed into it immediately. In the three years since this process was adopted and during which it has been applied to twelve bridges no case of separation of granolithic face has been observed, and not a single hair crack has been found, nor any kind of deterioration or tendency to discoloration noticed,—indeed, the weathering seems to make the surface cleaner and more stone-like.

In general, the washing is done on the day following that on which the concrete was deposited. Portland cement is used.

When a quicker setting cement than usual is met, or through some other influence the surface is found, upon removing the forms, to be too hard for the scrubbing brush, a wire brush is employed first, then a small block of wood or a brickbat with water and sand, which is found necessary to cut the film.

If the surface has hardened so as to require the grinding action of the sand and block the aggregate will not be brought out into very decided relief and the face will therefore be comparatively smooth. In cold weather when crystallization proceeds slowly the forms may require to remain two days before the

FIG. 22.—SQUARE CONCRETE BALUSTER FOR BRIDGE RAILING, SCRUBBED SURFACE.

washing can be done safely, and in very cold weather they have been left a whole week, and the scrubbing was successful.

Consideration of the cost of the process may involve the question of the design of the forms. When the work is such that not the whole height of it can be placed in one day it may be advisable to construct the form so that the planks can be removed without disturbing the uprights. This will add to the cost, but may be compensated for by the saving in planks. In the case of a long or heavy wall where only one course can be laid in a day only one course of planks is required.

If indentations are made at the joints between courses, the joints can easily be concealed. If the indentations are not desired

great care must be taken to scrape thoroughly clean the top of each course quite to the face and to use the same consistency of the new granolithic facing as that of the lower course. It is possible thus to make a joint that will not be very noticeable, but the vigilance of the inspector must not be relaxed at any point, and even then the joint will be at least distinguishable. The bead indentations are very convenient and useful in working, and in appearance they relieve what otherwise would be a large blank area.

FIG. 23.—1. CEMENT. 2. BAR SAND (NATURAL SIZE).

When the planks are desired to be removable the studs are set some distance from the face—8 inches to 12 inches—and the planks are braced against them by cleats nailed so as to be easily loosened. The planks are in one width the full depth of a course, either solid or made up of narrow planks battened together. A

triangular bead strip is nailed to the face at each edge and the layer of concrete is finished at the middle of the top bead.

When a plank is taken off it is scraped clean of adhering cement, then oiled, and reset with its bottom bead fitted into the half indentation just left by the top bead.

A couple of carpenters with perhaps a helper will take off and reset a course of plank, say 100 feet long, in four to eight hours. The course may be whatever is desired for either convenience or architectural effect. The yardage of concrete accommodated will vary also with the thickness of the wall and the proportion of face to back. Thus the cost of changing forms will vary from 25 to 75 cents per cubic yard. In building work generally the ordinary forms can be used. Of course care must be taken not to load members too heavily while they are green and naked, but the same care should be exercised with members still in forms because the forms while preventing collapse will not prevent injury to the concrete by undue pressure upon it.

The cost of the scrubbing is trifling if done at the right time. A laborer may wash say 100 square feet in an hour, or the same area if it has been permitted to get hard may take two men a whole day to rub into shape.

The early removal of the forms makes possible the neat repair of any blemishes that may be revealed.

The question of efflorescence is an important one in the consideration of the appearance of concrete structures. The scrubbed surface is not subject to the hair cracks that in some faces seem to absorb moisture during storms and then exude the white spreading disfigurement. But if there are joints in the work there is danger of the efflorescence, and observation leads to the belief that if within twenty-four hours of the completion of a course the top surface be carefully scraped to remove every particle of the "laitance," and then before depositing the next layer of concrete the scraped surface be coated with thin cement mortar, the joint ought to be impervious to moisture from either front or back, and no trouble with efflorescence ensue.

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DISCUSSION.

Mr. Boynton.—Mr. Humphrey suggested that the hair cracks would probably occur in a rough surface, but probably would not show owing to the roughness of the surface. May it not be that the smooth surface of the film is responsible for the hair crack and that it does not extend below the surface?

President Humphrey.—It is not as evident when you have a rough surface as when you have a smooth surface, but nevertheless the shrinkage does occur on this rough surface after a long time.

Mr. Boynton.—I have in mind a structure that was built of concrete blocks, that were molded in a sand mold. For some reason a portion had rather smooth surfaces, as if they had been troweled over. In these blocks there were hair cracks, but in those with a rough surface scarcely any cracks were noticeable, and I believe that there were actually fewer there.

President Humphrey.—The chair thinks unquestionably, in a rough surface, or a surface in which there is relatively very little neat cement, the appearance of hair cracks is much smaller and less pronounced. Of course, it has shrinkage cracks, but the richer the mixture the more pronounced they are.

Mr. C. Walker.—Mention was made in the paper of the treatment of concrete surfaces in Germany. I have seen some of this work done. All the ornamental and plain work was done in the factory, and as it was sent along on the benches a float was prepared and covered with felt. Each piece was floated just as soon after molding as possible. Just as soon as they were through with the neat cement the float was washed off and another one used. In this way it is possible to obtain very fine plain work. I have made water tables and sills that way, and it is very hard to distinguish them from rough sandstone.

Mr. P. P. Comoli.—I have heard a great deal about the difficulty in removing the smooth surface of concrete. It is easy enough to use the rough boards, and not pay any attention to

the smoothness of surface while the concrete is put in the form, and then treat the surface after the forms are removed. In applying the cement, you must remember that mortar should not be applied to that concrete in a manner that mechanics are doing it, putting it on with a flat trowel. In the French government work we are not permitted to use mortar in that manner. The mortar is thrown on in such a way that it will penetrate the pores of the concrete; then it is immaterial how the second coat is put on, as it will at once adhere very strongly. The mortar is then applied with a trowel float.

A rough cast surface can best be put on with a broom dipped into a solution of mortar, half and half, or two to one, whatever the case may be, and applied by stepping back a distance of two or three feet from the wall and striking the broom with the hand in such a way as to drive the mortar against the wall, on which it collects like raindrops. The cement crystallizes and adheres to the wall, making it waterproof, and I guarantee that it will never peel off. There are many other methods that can be applied to give a pleasing effect. A float finish, on a building, is a very common piece of work, and any man who has seen such a system will be surprised how its appearance may be improved. You can stain the cement any color desired except green. That is one color I have not yet been able to produce. Upon being exposed to the sunlight it will fade away. Another finish which is sometimes used is to scrape the surface, say ten or fifteen minutes after floating the mortar. It seems to me that this system has an injurious effect, since whenever a pebble is removed a hollow is left.

The rough cast finish does not destroy its lasting qualities, and if desired it can be made to appear as though interlaid with different material.

MR. E. S. LARNED.—The force of Mr. Comoli's statement in regard to the adhesion of the coating surface to concrete appeals to me very strongly. I know perfectly well from my own experience that if you take a two or three-to-one mortar finish, and simply throw it lightly on a concrete surface, and then bring it to grade by use of a straight edge, you do not obtain the perfect bond between that surface and the under-concrete that you

could get if the material were applied with force. It seems to me that is self-evident, and any man can prove it to his own satisfaction by trying to put two surfaces together in that way. You must work the material and cement practically into each other if you are going to make them bind. I have seen a skin coat made to stick to a hard concrete surface, and I have seen a beautiful surface produced, but it is at the expense of hard elbow grease and muscle. If that same idea is carried out in the working surface on concrete, particularly sidewalk construction, you will have sidewalks that won't show surface peeling.

Another idea on which I would like to hear some practical men speak is the difference in the use of the word float trowel and the steel float trowel. I have the idea that it makes quite a difference in the floating of cement whether you use a steel trowel or wood trowel. I am told by men who are using the trowels that it makes all the difference in the world,—that a cement surface that is floated with a wood trowel won't crack or peel as easily as if it is floated with a steel trowel. If there are any practical men who have used both tools I would like to hear from them.

MR. P. P. COMOLI.—In constructing the roof of a porch the workman had neglected to put the rough side of the boards up, that is, against the concrete. With the usual method of finishing a smooth concrete surface it was found impossible to make the mortar adhere to the concrete. We mixed a 1 to 2 mortar to the consistency of cream and threw it with force against the concrete surface with a large trowel. The rough surface thus produced was permitted to harden until the following day, when a mortar applied in the usual manner with a float gave no further trouble.

I believe that the float or trowel has nothing to do with the finish of the surface of floors and sidewalks. It is simply a question of system. In smoothing the surface you must wait until the set is produced to a certain degree, then you have a beautiful surface. Finishing with a float gives a more or less grainy surface, which does not wear as well as a troweled finish.

MR. GEORGE L. STANLEY.—I have used float finishing considerably on both sidewalks and floors, and have had no difficulty

whatever with crazing or hair cracks. Of course, the float, to do good work, should be made of hard timber. A float made of beech or birch is the best I have found to use, although it won't run the surface quite as smooth as if finished with a trowel. In good work the float should be drawn with the straight run right along the wall, not twisted or turned. In some of our cities and villages a troweled finish is not permitted, but a float finish required. A float finish, if carefully done, will, I believe, answer all purposes.

MR. C. WALKER.—The difference between the action of the steel trowel and the float is this: the steel trowel will bring the neat lime to the surface of the wall in the white coat finish, or the neat cement in the hard coat finish, while a float draws the sand more to the surface and leaves it rougher. In Germany the steel trowel is only used in stucco work. For other work a wooden float or one covered with felt is used. A felt-covered float, while giving some beautiful effects, is very tedious in application.

MR. LARNED.—My idea in bringing out this point was with a view of showing how one method would result in crazing or hair-cracking more than another, and my impression is confirmed by the statement of the last gentlemen, to the effect that the steel float does bring the neat cement to the surface, and if overtroweled it brings too much to the surface, and in consequence results in crazing or hair-cracking.

MR. P. P. COMOLI.—Any man who has traveled in Europe must acknowledge that more attention is paid to the artistic treatment of a building there than elsewhere. Very few buildings are left plain, almost all being faced with some other material than that of which it is constructed. Cornices and balconies are all placed in position, and the treatment, so far as the effect is concerned, is done after the work is in shape.

I am sorry to say that in St. Louis all surfaces I have ever seen have been finished with a wooden float. It is true it does not bring out the checking that the trowel will, but there are methods of avoiding that.

In the first place, the workman must use common sense in preparing the work to receive the finish, as the method of treating

a surface is subject to the humidity of the air and the time of year in which the work is done.

Suppose when we build the wall we make no attempt to get it plumb, square or level, whatever the case may be. Before the rough cast or Tyrolean finish is put on, the wall must be trued up and all angles brought to shape. Let us suppose you have a wall ready for finishing. The condition of the concrete in the top of the wall which was molded last differs from that in the bottom which was molded earlier. The suction of the concrete in the top of the wall will be much greater than that in the bottom.

You must wait until the cement has all turned one color, that is, all has the same suction. Then you can put on your rough cast with a broom, as I have already described. I have seen some people start at the bottom and work up a wall. That is poor practice, since the bottom will become dirty and discolored before the top is completed. With this method of rough casting I can put in a fifty-foot front, two stories high, in one day; that is, for the last rough cast. The kind of weather, whether clear or cloudy, influences the ease and rapidity with which the work can be done. If the weather is hot the work must be kept wet, as is done with walks, or in any other work. But we generally like to do that work in the fall or spring, rather than in the hot summer days, and avoid them, unless it is a small job which we can protect.

Cement, the moment you put water to it, is a living substance. If you give it proper treatment it is excellent; if you neglect it, poor results will be obtained. There is where the greatest trouble with the hollow block lies, too. Many things are neglected.

THE TREATMENT OF CONCRETE SURFACES.

LINN WHITE.*

A pleasing and consistent surface finished generally has but little to do with the strength of a concrete structure, but it is not inconsistent with maximum strength in any structure.

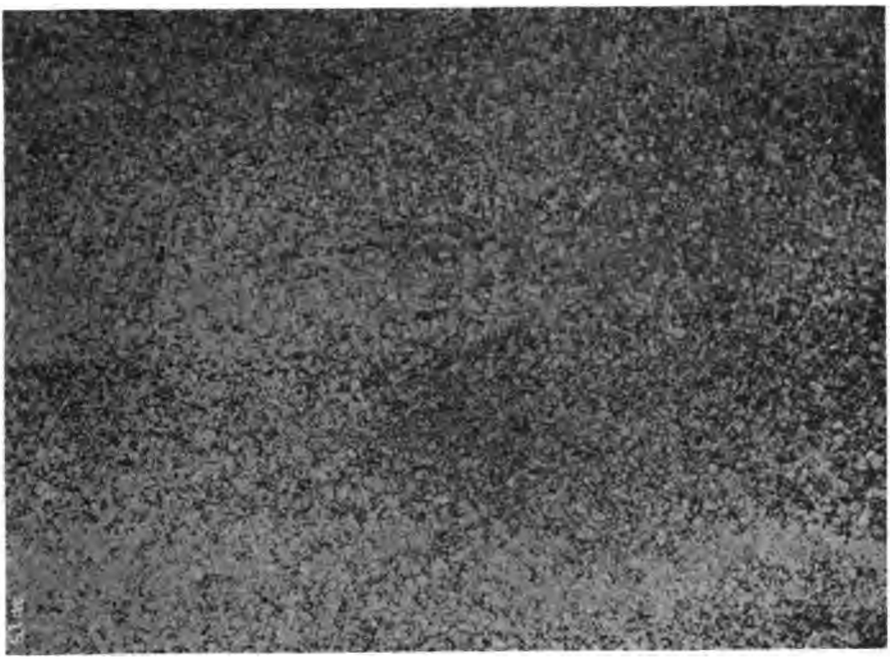

FIG. 24.—GRANITE CONCRETE AFTER ACID TREATMENT.

Next to form or design the character of the surface has most effect on the appearance of concrete whether in a building, arch, wall or abutment, in fact, when the view is had at a very close range, or in such structures as retaining walls or pavements the surface finish may take precedence over proportion.

*Engineer, South Park Commissioners, Chicago, Ill.

It is not intended to attempt a full discussion of the subject, but only to describe some methods used in trying to obtain satisfacory surfaces in the various classes of concrete work done in the South Park System of Chicago.

The imperfections in the exposed surfaces of concrete are due mainly to a few well-known causes which may be summed up as follows:

1. Imperfectly made forms.
2. Badly mixed concrete.
3. Carelessly placed concrete.
4. Efflorescence and discoloration of the surface after the forms are removed.

Forms with a perfectly smooth and even surface are difficult and expensive to secure. Made of wood as they usually are, it is not practical to secure boards of exact thickness, joints cannot be made perfectly close, the omission of a nail here and

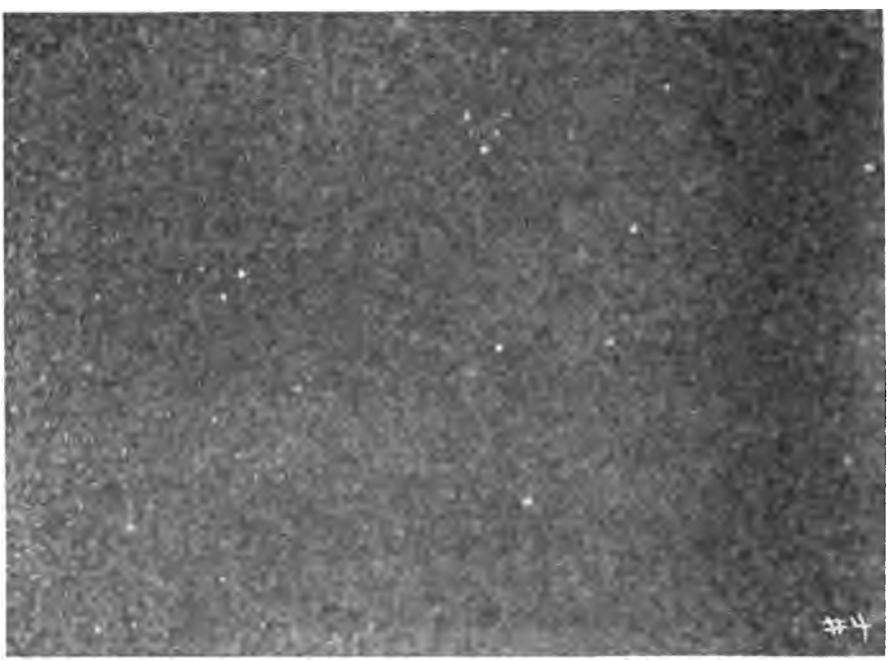

FIG. 25.—CONCRETE SURFACE—ACID TREATED.

FIG. 26.—CONCRETE SURFACE—ACID TREATED.

there allows warping and the result is an unsightly blemish where least wanted.

Badly mixed concrete gives us irregularly colored, pitted and honeycombed surfaces with here a patch of smooth mortar and there a patch of broken stone exposed without sufficient mortar. Careless handling and placing will produce the same defects.

But granting we have the best of labor, that all reasonable expense and care is had in making up forms, in mixing, handling and placing the concrete, that it is well spaded, grouted, or the forms plastered on the surface, the results are not satisfactory. All these efforts tend to produce a smoothly mortared surface, and the smoother the surface, the more glaring become minor defects. The finer lines of closely made joints in the forms

become prominent, the grain of the wood itself is reproduced in the mortar surface, hair cracks are liable to form, and, worst of all, efflorescence and discoloration are pretty sure to appear. We surely have been working on a wrong theory.

It is of doubtful efficiency to line the forms with sheet metal or oilcloth. Imperfections still appear.

Two methods suggest themselves as likely to overcome the defects alluded to above, (1) treating the surface in some manner after the forms are removed to correct the defects, and (2) using for surface finish a mixture which will not take the imprint off and which will minimize rather than exaggerate every imperfection in the forms and which will not effloresce.

Methods of treating the surface by bush hammering, tooling and scrubbing with wire brushes and water have been described in various published articles, all of which have for their object the removal of the outer skin of mortar in which the various imperfections exist. But the method most used in the South

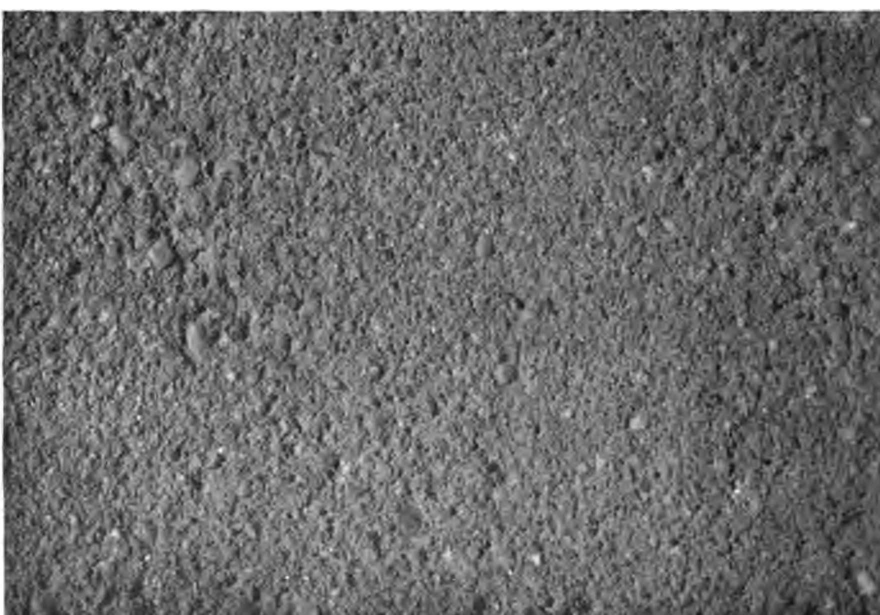

FIG. 27.—CONCRETE SURFACE—ACID TREATED.

FIG. 28.—GRANITE CONCRETE COLUMN BASE—SURFACE ACID TREATED.

Park work is the acid treatment. It consists of washing the surface with an acid preparation to remove the cement and expose the particles of stone and sand, then with an alkaline solution to remove all free acid, and finally giving it a thorough cleansing with water. The operation is simple and always effective. It can be done at any time after the forms are removed, immediately, or within a month or more. It requires no skilled labor—only judgment as to how far the acid or etching process should be carried. It has been applied with equal success to trowled surfaces, like pavements, to molded forms, such as steps, balusters, coping, flower vases, etc., and to concrete placed in forms in the usual way. It, of course, means that in the concrete facing only such material shall be used as will not be effected by acid, such as sand or crushed granite. It excludes limestone.

The treated surface can be made of any desirable color by selection of colored aggregates or by the addition of mineral pig-

ments. The colors obtained by selection of colored stone are perhaps the most agreeable and doubtless more durable.

There have been molded in the South Park shops blocks for buildings, columns, architectural moldings and ornaments with both red and black crushed granite, all treated with the acid to bring out the material colors of the stone. There has been a large quantity of concrete pavement laid with torpedo sand surface colored a buff sandstone color with a small quantity of yellow ochre and mineral red and treated with acid. The buff color imparted to the surface is a welcome relief from the glare of the ordinary whitish gray concrete pavement in the sunshine, and the etching of the surface adds to the softness of the color, at the same time preventing any slippiness. This same buff color has been used to a large extent in steps, bases of lamp posts, and other molded articles to be placed on or near the ground. With sand as the aggregate thousands of pieces have been

FIG. 29.—AN ARCH BRIDGE.

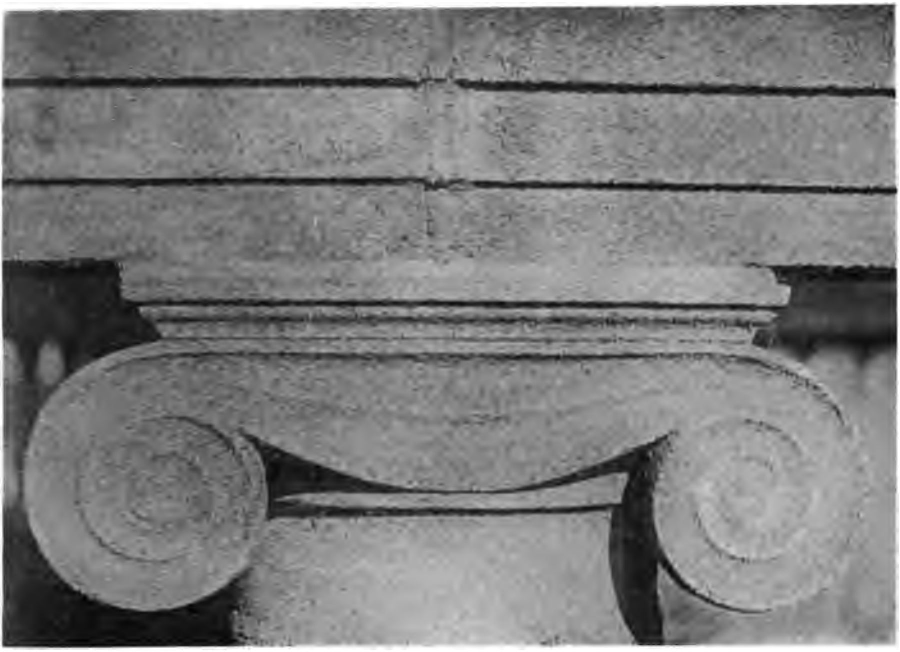

FIG. 30.—GRANITE CONCRETE COLUMN CAPITOL—SURFACE ACID TREATED.

molded for coping, balustrades, concrete seats, drinking fountains, pedestals, etc., which, when treated with the acid, appear like a fine-grained, almost whitish, sandstone.

Where there are projections or marks left by the molds or forms they are tooled or rubbed down before treatment, and where it is necessary to plaster up rough places or cavities in the surface, it may be done and after treatment cannot be detected.

These various classes of work have been done on a large scale during the last three years in connection with the improvement of new parks and has in all cases proved satisfactory.

The second method of preventing or minimizing surface defects has also been tried in the South Park work with quite a measure of success.

During the years 1904, 1905 and 1906, groups of concrete buildings have been erected in nine different parks, costing with

their ascessories, from \$65,000 to \$150,000 for each group. These buildings are all monolithic structures with occasional expansion joints, the exposed surfaces of walls being of a concrete composed of one part of cement, three parts of fine limestone screenings and three parts of crushed limestone known as the one-quarter-inch size. This was thoroughly mixed quite dry so no mortar would flush to the surface, and well rammed in wooden forms made in the usual manner. The result was an evenly grained, finely honeycombed surface, of a pleasing soft gray color, which grows darker with time and blends admirably with the park landscape. In placing it was not spaded next the form, it was too dry to cause any flushing of mortar so there is no smooth mortar surface, the imprints of joints between the boards hardly noticed, and the grain of the wood not seen at all. There is no efflorescence apparent on the surface anywhere and cannot be on account of the dryness of the mix and the

FIG. 31.—ENTRANCE SHERMAN PARK, CHICAGO, ILL.—SURFACE CONCRETE ACID TREATED.

FIG. 32.—GRAVEL BRIDGE OF CONCRETE—SURFACE ACID TREATED.

porosity of the surface. The buildings are used as gymnasiums, assembly halls, reading and refreshment rooms, and as a rule the same gray concrete finish is given the interior walls as the exterior. In some cases a little color has been applied on the interior walls, and the walls of shower and bath rooms have been waterproofed with plaster. The porosity of the surface makes it well adapted to receive and hold plaster.

This sort of surface is not capable of treatment with acid as a smoothly-mortared surface, nor is it desirable. Consequently the only color obtainable is the natural color of the cement-covered stone, but which is softer and far more agreeable than the gray of the usual mortar-finished surface. It is not suited for the surface of a pavement and is not impervious to water. Although it is evident the water enters the pores to a considerable extent there is no evidence of injury from frost during the two winters some of these walls have stood.

The same finish has been used for retaining walls, arch bridges, fence posts, walls enclosing service yards, etc. In the buildings the thin walls were made entirely of this mixture, while in the heavier structures it has been used only as a facing. Two reinforced arches of sixty-feet span were faced with this mixture, but the steel was inbedded in a wetter, more impervious concrete. This same dry mixture can be used for molded stones when the mold is open enough to permit tamping, and, of course, it is eminently suited to block machines.

The dry, rich mix with finely crushed stone has been found specially suited to another condition where a sound, smooth

FIG. 33.—GRAVEL BRIDGE—CONCRETE ACID TREATED.

surface was particularly difficult to secure, viz: for the under water portion of a sea wall on Lake Michigan. It was mixed very dry and dumped in mass in sunken boxes joined end to end, made fairly water-tight, but from which the water was not excluded. With the finely crushed stone a sound, smooth surface was obtained (when the sides of the boxes were removed) where it was manifestly impossible to plaster or grout the surface, and where spading a mix of coarser stone simply washed the cement away from the surface stones. On account of the variable water level it was particularly desired to have a sound, smooth surface.

Of the work described, most of the monolithic buildings, the arch bridges, and some of the walls and paving have been done by contract. All of the molded work, the buildings made

FIG. 34.—BUILDING, SHERMAN PARK, CHICAGO, ILL.—SURFACE CONCRETE ACID TREATED.

of blocks, service-yard walls, etc., and all the acid treatment has been done by the park forces. Nearly all the various brands of Portland cement sold in the Chicago market have been used in varying quantities with equally good results.

In both methods described honest work and careful inspection are as necessary for good results as in any other first-class construction. Neither method cheapens concrete work. The acid treatment slightly increases it. The surfacing with fine crushed stone adds nothing to the cost.

By the acid treatment, together with rubbing and chipping, all irregularities can be corrected. With the fine crushed-stone surface all irregularities and form marks are not prevented, but they are greatly minimized.

In not all the work done by the second method were the results entirely satisfactory. The original specifications called for one-half-inch stone which was afterwards changed to one-quarter inch. Experience taught the correct quantity of water to use for best results. But altogether both methods are so satisfactory that their use will doubtless be continued in the South Park work until something better is developed.

DISCUSSION.

MR. J. G. HAMILL.—Mr. White, did you say you did not or could not apply acid to limestone faces?

MR. WHITE.—We have never attempted any finished work with it at all, knowing that most acids leave some effect on limestone. The acid treatment has been confined to our experience to granite surfaces and sand.

MR. E. S. LARNED.—Mr. White, what kind of acid do you use and what is the strength of the solution?

MR. WHITE.—The solution was patented by Mr. Black and Mr. Richards, of the South Park, Chicago, and while I do not feel at liberty to give its composition, the acid is on the market and can be readily obtained almost anywhere.

The strength varies somewhat. The commercial acid, not the concentrated acid, is usually diluted with its own volume of water before using on the surface to be etched. No doubt, the concentration of acid bought in this way varies considerably, and experience will guide one as to just what dilution is necessary. One will also have to be guided somewhat by the depth of the etching desired. Working on a finely crushed surface, the etching is much more rapid than on one in which a coarser granite or sandstone is used. In such a case it would be found advantageous to use an acid somewhat stronger, or permit it to remain on the surface a little longer to produce the desired effect.

MR. E. S. LARNED.—I am very greatly interested in this, but do not want to press Mr. White with unnecessary questions, but would like to ask in regard to the length of exposure of the acid application, and how soon he feels it necessary to wash it off?

MR. WHITE.—If it is applied before the cement has obtained its full hardness and full strength, we will find its action considerably more rapid than if applied to an old surface that has been exposed to the weather for some time. After the concrete has been standing a certain length of time, depending on the weather, I believe any additional time will have but little effect on the

rapidity with which the acid will act. If it stands for a year it will be acted on just as easily as at the end of six months, but not as easily as on a fresh surface.

Most of our work is done as soon as the block is formed, or as soon as the forms are taken off of the wall. On pavements, on which we have used it to some extent, it is done, say, the day after the surface has been troweled. Of course, in that case, it is pretty hard, but yet has not attained its full hardness.

As I stated before, the length of time it takes the acid to have its effect, depends on the coarseness or fineness of your aggregate. With a finely crushed granite and fine sand, fifteen minutes may accomplish the desired result. In other cases it may be necessary to leave the acid on fresh work for an hour or even to repeat the operation. After the surface has been etched the desired amount, the excess acid and loose sand are washed off with water.

MR. P. P. COMOLI.—I believe that this solution is an excellent thing for a man who makes a business of cast blocks, and who wants to produce a certain grain, such as an imitation granite, or other stone.

MR. WILLIAM PERRY.—I have found that muriatic acid will remove the film of the cement from the surface. In the case of cement blocks, it is not at all necessary to use acid. I have found it very profitable to take a cement block, which has a smooth surface, not a rough face, turn it over on a stone slab on which there is sand and water, and by a few rubs all the cement is removed and the aggregate plainly exposed. Of course, it is necessary to use acid on a wall in a structure.

MR. C. W. BOYNTON.—What impressed me about the columns in Hamilton Park, to which Mr. White referred was their sharp outline. They are fluted columns and the corners are perfectly sharp, and if they had been treated with acid, it would seem that the sharp corners might have been lost. Those columns may of course be made of some composition entirely different from concrete.

MR. WHITE.—That is only of this crushed limestone finish, showing the molded form without acid or any other subsequent treatment.

MR. BOYNTON.—There is one thing that is very attractive about these columns. Although they are perfectly uniform, they do not show the smooth, molded appearance of the usual molded structures. They show a grainy and perfect surface.

A MEMBER.—I would like to ask the gentleman if he estimated the cost between one of those concrete columns and a similar one of solid granite.

MR. WHITE.—I have no comparative figures, but I am quite sure what the comparison would show. The cost of producing the surface, the extra cost, over and above the ordinary concrete, will consist of the small quantity of crushed granite you would use in the facing and the application of the acid. That would be represented in any case by a very few cents per square foot of surface exposed. Of course, the surface exposed is the basis on which the cost of the treatment would be figured. The cost on such work as is shown in one of the photographs, showing the architectural finish on the base and capital of the column, requires considerably more care, and probably would require the use of considerably more acid to get the desired effect, but even in that case it would be limited to only a few cents a square foot at most.

MR. WATSON.—The photograph of one of the buildings shown by Mr. White indicated as a whole considerable variation in the color of the blocks of stone. That may be due to the reflection of light, or it may be due to treatment. If each block were treated separately, as cast in the shop, would not that produce a difference in the appearance of the blocks, so that when set in the wall they would show that unevenness of finish which the photograph indicates.

It seems to me this would be the case unless great precaution were taken that each block should be the same age when treated at the shop, receive the same strength of acid, and the same length of treatment?

MR. WHITE.—I think any difference in the appearance in the color of the block would be mainly due to difference in the material used for the surface material, and not in any sense to the acid treatment. Of course, one block may have a little stronger color because of a longer treatment with acid, which would tend to bring out the color of the aggregate a little better.

I believe, throughout the building, there is, of course, a certain variety in the appearance of the blocks, but I think that would be generally due more to some accidental difference in the mixture of the stone used, or perhaps the play of light or weather exposure. That building has now been erected several years and of course some portions of it are exposed a little more to the weather than others, and there is a slight difference in the weather exposure, but otherwise there is a reasonable uniformity in the appearance of the blocks—no more variation, perhaps, than is pleasing.

The illustrations in this paper are loaned through the courtesy of the *Cement Age*.

REPORT OF COMMITTEE ON ART AND ARCHITECTURE.

BY CHARLES D. WATSON, *Chairman.*

The necessity for further study and experiment to make concrete adaptable for use in the higher grade of work where artistic effect is required is beginning to be realized, and urgent demands for improvement are being made by the technical press. As one editor says, he reveals no secret when he states that "A good looking concrete bridge or building is an exception." It is just as important that methods be devised for improving the appearance of concrete as it is to devise methods by which we can eliminate defects in structural design and execution of the work, a subject much discussed at the present time.

It is necessary, in reviewing the progress made, to discuss separately the three different classes of concrete work:

Monolithic concrete.
Cement block buildings.
Manufactured stone.

The views of those engaged in these three different lines of work vary considerably, as regards the treatment of the material. The monolithic man insisted that cement should not be used in imitation of stone. The manufacturer of cast stone insists that his product is as true a stone as any natural rock quarried, and therefore cannot legitimately be treated in any other way except as stone, while the manufacturer of cement building blocks is divided between the two, depending upon the class of work he is doing. Without doubt the views of the monolithic man and the manufacturer of stone are both right. The treatment of concrete depends largely upon the kind of concrete. It has not been long that architects and engineers recognized that there was more than one grade of concrete. The mixture of cement with any kind of aggregate in certain pro-

FIG. 35.—SCREEN AND GATE HOUSE OF PLANT OF ONTARIO POWER COMPANY, CANADA, CONSTRUCTED OF MANUFACTURED STONE.

portions, with little reference to size and character, was apparently all that was expected. With the introduction of concrete for superstructure work, the necessity of more scientific methods has been forced upon us, with the result that we have practically reversed some of the original theories, such as the amount of moisture required, and the necessity of more careful selection of aggregate. The most difficult problem that confronts those interested in the improvement of the appearance of concrete is in monolithic construction, such as bridges, retaining walls, and heavier classes of masonry. Improvement in this class of work is necessarily of the greatest importance, as the bulk of concrete work is of this nature. Of the various methods applied to date, that of tooling, either by hand, or by pneumatic tools, seems to be the best. The older methods employed, such as plastering and washing, have not proven

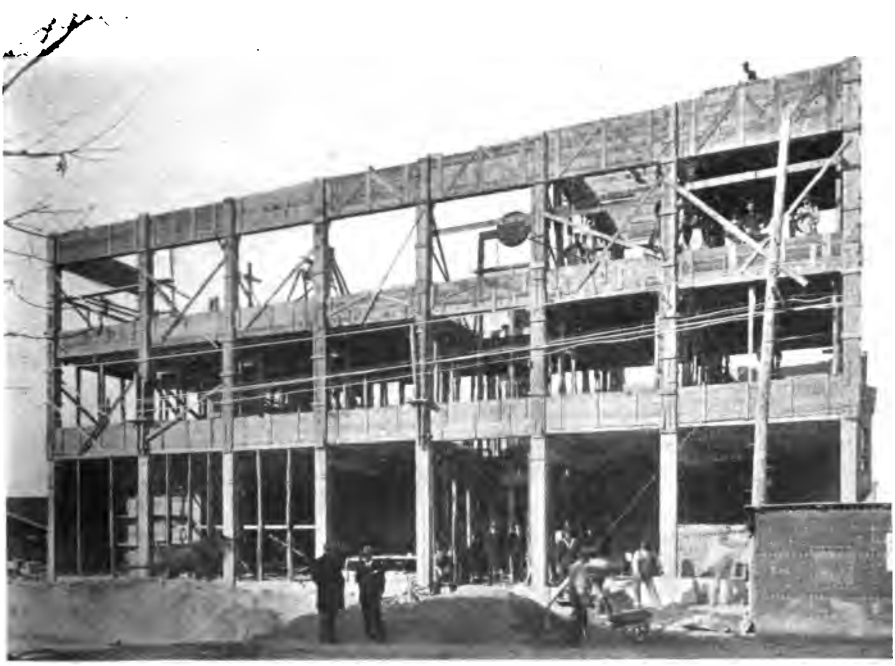

FIG. 36.—REINFORCED CONCRETE SKELETON, SCREEN HOUSE, ONTARIO POWER COMPANY.

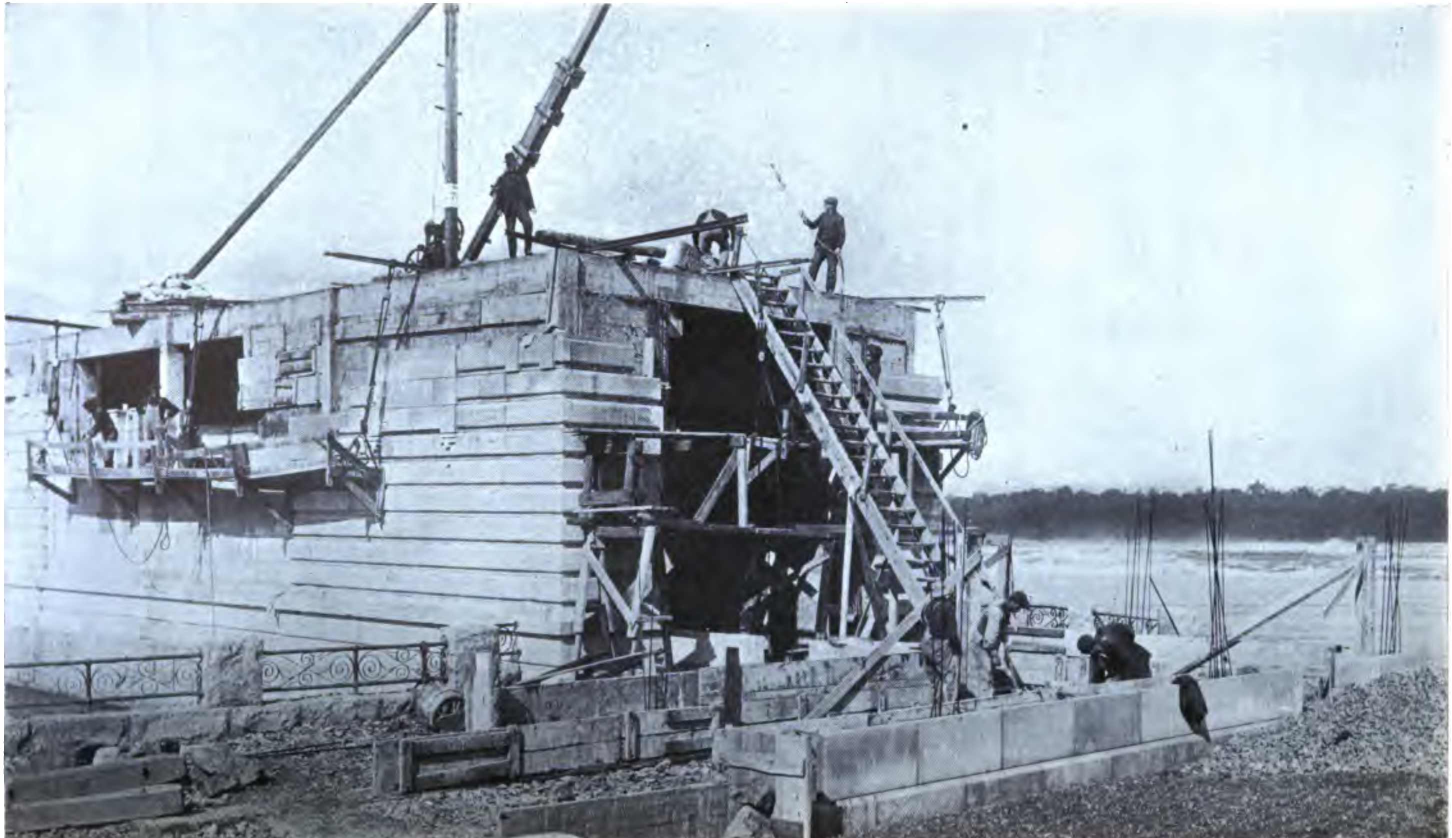

FIG. 37.—SETTING FACING AND BACKING SCREEN HOUSE, ONTARIO POWER COMPANY, NIAGARA FALLS, CANADA.

very successful, at least in America. This condition is probably due more to lack of experience in application than to the method.

There has lately been introduced, and from reports quite successfully, a method of washing the concrete while green, in this way removing the cement and sand and exposing the coarser aggregate of the concrete. Foremost of those who have experimented along these lines is Mr. Henry H. Quimby, whose illustrated articles in "Cement Age" and "Engineering News" have shown some excellent results.

The principal difficulty in employing this method in actual practice is the necessity of removing the forms to enable the concrete to be washed while it is still in a green, or comparatively soft condition. There is a large field for further experiment in this branch of the work. The necessity of overcoming the dead and monotonous gray color of cement is what appears

FIG. 38.—MANUFACTURED STONE IN STORAGE FOR ONTARIO POWER COMPANY SCREEN AND GATE HOUSE.

most important. The variety of results to be obtained by the use of various colored aggregates offers a large field for experiment, but whatever the method it is apparent that it must be based upon some plan to remove the coating of cement which surrounds the aggregate and gives the mass of concrete its color, whether it is done by dressing or by washing.

In the field of cement block construction the progress during the past year has been most noted for the improvements which have been adopted in the design of the face of the blocks. It would appear that cement block manufacturers had originally in some way conceived the idea that the only successful way to make a block was to imitate the rock or quarried-faced natural stone. They seemed to have lost sight of the fact that structures built of rock-faced natural stone in which each stone was the same size and color throughout, the building would be as equally inartistic as the rock-faced hollow block.

FIG. 39.—CARBORUNDUM WHEEL TOOLING MACHINE.

An artistic rock-faced natural stone building depends upon having the proper amount of irregularity in the size and bond of the stones. Block manufacturers who still adhere to the rock-faced design seem to be appreciating this fact, and are adopting means by which they are able to vary the size of the block, and the results are showing a decided improvement in the appearance of their structures. It is a question whether, from an architectural standpoint, concrete blocks should be made of this pattern at all. It is impossible to imitate the quarried face of natural stone, and it is doubtful if any architect would allow such a finish in natural stone above the water table if it were not for the fact of its economy. The smooth, or tooled finish, inasmuch as it is artistically produced in cut stone, is probably the best model for the cement block manufacturer. Of course, the block manufacturer recognizes that in the rock-faced design the requirements and execution of the work, such

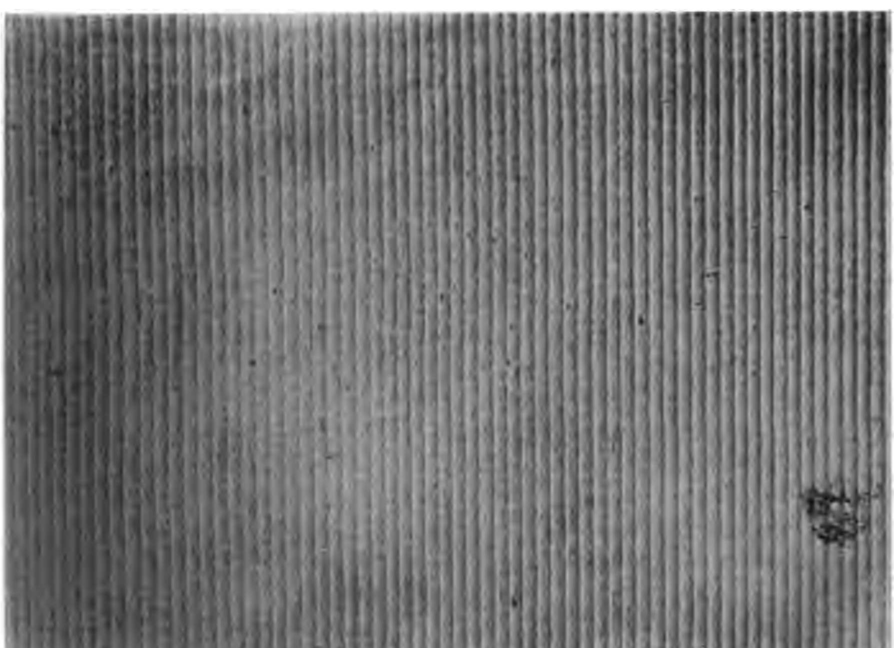

FIG. 40.—SURFACE MANUFACTURED STONE TOOLED BY MACHINERY.

as the keeping of straight arises and uniform joints are not so important, but it is improvement in the grade of the work, and not means of hiding the defects that the architects are demanding. The greatest difficulty in cement block manufacture, as well as in monolithic concrete construction is in overcoming the natural color of the cement. It seems that the mixture of various colored pigments has not thus far solved the difficulty.

From present appearances it would appear that the solution of this vexatious problem in concrete construction is going to come from the use of a manufactured stone for the facing of the structure in the higher grades of architectural work. Most writers, in discussing the means of improving the architectural appearance of such structures, seem to forget that the first necessity in appearance is in having the concrete of the proper density, and made from such an aggregate that the finish once given shall remain permanent. In monolithic construction it is impracticable, if not impossible, to put in concrete for the surface which is of the proper grade to allow of a satisfactory finish. In cement building blocks where the concrete is mixed comparatively dry it is beyond doubt a physical impossibility to make a concrete dense enough to resist the discolorations brought about by absorption.

With factory made stone on a process which allows the use of a proper amount of moisture, where the aggregates can be carefully selected and proportioned, where the casts can be seasoned and finished and the whole work performed by scientific methods under systematic and expert supervision, it is possible to make a concrete whose absorption is less than most of the common building stones, and whose texture is such that it can be finished in the many various ways in which natural stone is finished, giving without a doubt a material equal to natural stone in appearance, much more durable, and considerably cheaper. Of course, it must be recognized that a high grade of manufactured stone of this nature is necessarily more expensive than monolithic, monolithic concrete or concrete machine-made blocks, but with the labor-saving devices now being introduced for the manufacture, handling and finishing, there is every indication that in concrete stone lies our greatest

hope. With the advance of concrete for structural uses lies enormous possibilities for the use of manufactured stone. Heretofore manufacturers were compelled to make stone of the sizes of the natural stone of which their product took the place, but with reinforced concrete the stone facing can be reduced to an exceptionally thin veneer, which in many cases can be used in place of forms, thus effecting a large saving in the cost of this class of structure, and settling all questions of the external appearance of the structure.

The branch building of the Canada Permanent Mortgage Corporation at Regina, Sask., was erected on this system of construction, and designed by the Roman Stone Company. Mr. R. J. Edwards, architect. The building is concrete throughout. Its two elevations are faced with cast, or Roman, stone, as the product is called. The structural concrete frame was erected similar to the ordinary system. The walls were filled in after the frame was completed. The stone facing, with crimped galvanized steel ties cast in the back, was set in place similar to any masonry construction. The inside facing of the wall was then set up with four-inch terra cotta. The crimped steel ties were passed through the joints of the terra cotta, and the intervening space filled with plastic concrete.

Experience has shown that the stone facing on a structure of this kind can be made as thin as 3-inch without difficulty, and without reinforcing. Where reinforcing is introduced, these sections can easily be cut down to two inches, and in some cases to one and one-half inches, thus materially reducing the cost of the facing, and the expense of handling. It is not more difficult to hold in position than it is to put in a properly surfaced wooden form. The steel ties afford an excellent means for fastening the facing securely to the terra cotta backing, and where necessary spacers can be used until the intervening space is filled with concrete. The ties not only secure the facing to the wall proper, thus preventing any cracking and settlement, but they also make an excellent tie for the porous terra cotta backing.

Figure 35 is a general view of the screen and gate houses of the Ontario Power Company at Niagara Falls. Those buildings were designed by Messrs. Green & Hicks, architects, of Buffalo, and were erected in a similar manner.

Figure 36 shows the reinforced concrete frame of the screen house after completion. The concrete structure in these buildings was done by the New York Concrete Construction Company, the walls by the Roman Stone Company of Toronto.

Figure 37 shows the work of setting the facing and backing on the latter building during the course of construction. It was not necessary to plaster this building, therefore, instead of using porous terra cotta for the inside form, were used the ordinary wood forms, such as would be done in masonry work, but the stone facing was tied to these forms by the use of fine wire, which was afterwards cut off and left in the concrete.

Figure 38 shows the stone in storage for these buildings. It will be noted that the ties for bonding into the backing are distinctly shown.

A description of the methods employed in the manufacture

FIG. 41.—BUILDING, CANADIAN BANK OF COMMERCE, LONDON, ONTARIO.

of this stone were given in my address before this association last year at Milwaukee. I will not take time to go into the details again, only to say that it is made in what is known as the wet process of casting in sand. The aggregate now used is pure white marble of a very course crystalline variety. This marble is crushed and screened into various sizes. The proper proportions of each size of the aggregate are taken to insure density.

Previous to this year the finish of the stone was produced by making the finish of the patterns the same as what was desired in the finish of the stone. A great improvement has been made over this during the past few months. All the stone is now cast with a smooth face and afterward tooled by the use of a tooling machine, invented for the purpose. This machine consists of carborundum wheels run on a mandel. As illustrated in Figure 39, the machine is pivoted so that it can be run at any angle. Thus, instead of having to adjust the stone, as is done in machine planer work in natural stone, the machine itself is adjusted. The machines can be made portable. The cutting wheels consist of a disc of carborundum of any diameter or thickness required, which gives almost any variety of tooled work necessary. The wheels are driven at a very high rate of speed and cut very rapidly. In fact, an expert operator can cut several square feet a minute. The effect produced by this cutting of the surface is very pleasing. It eliminates entirely any cast or artificial appearance on the surface of the stone, and from the fact that the wheels grind instead of chip it can be used on stone in a very green condition, the carborundum cutting through the coarse and harder aggregates without breaking it in the least.

Figure 40 is a photograph of the surface of a stone thus tooled. It will be noted that there is just enough vibration in the machine so that the tooled lines are not perfectly regular. This gives a very pleasing and natural effect, in fact, almost identical to hand-worked stone. This cutting of the surface also is of a distinct advantage in eliminating the surface checking or hair checks, which has always given more or less cause for trouble to the manufacturer of stone. The cutting of the crys-

tals of the marble gives to the appearance of the stone a glisten and life which is very beautiful, and altogether the innovation has proven a distinct success.

It seems to have been demonstrated conclusively that with proper care in the selection and grading of the aggregate the proper seasoning of the casts, and by machine cutting and finishing the surface that an artificial stone can be made equal in appearance to the best natural stone. As regards durability it was shown from tests recently made at the Toronto university on stone made by this process in conjunction with similar tests on a dry tamped concrete block, Ohio sandstone and Bedford, Ind., limestone, that Roman stone, at the age of two years, had in several instances as low an absorption as nine-tenths of 1 per cent, and a crushing strength of over 7,000 pounds per square inch. The best result on Bedford, Ind., limestone showed an ultimate compressive stress of 3,500 and an absorption of 5 per cent. Ohio sandstone showed 7,000 pounds compression and 5 per cent absorption. The best sample of stone made by the dry process at the age of two years showed about 2,500 pounds compressive strength and an absorption of over 12 per cent.

There are now several companies throughout the country who have as their object the production of a high-grade cement stone and who are co-operating with each other to perfect the product. During the past year, most satisfactory progress has been made in the perfection of the material.

The work of educating the consumer to a realization of the merits of the material and a consequent higher selling price has been most difficult, but if the present standard is maintained and as much progress made the coming year in the reduction of cost by the perfecting of machinery and shop methods as there has been the last year in the perfecting of the material itself, it is safe to predict that the time is not far distant when the contractor for concrete structures of all varieties will have at his disposal a complete solution of the vexatious problem of providing a pleasing and economical appearance to concrete structures.

The illustrations in this paper are loaned through the courtesy of the "Cement Age."

DISCUSSION.

MR. E. S. LARNED.—I would like to ask Mr. Watson if he has ever tried a sand blast in dressing a concrete surface.

MR. WATSON.—I have tried the sand blast but did not find it very successful. The difficulty is to get a uniform blast on the stone. It would take it out too deep in one place, and not enough in another. It does not seem possible to use the sand blast and get a uniform result.

MR. E. S. LARNED.—That might not have been a valid objection to the system. We have been undergoing a sort of resurrection in Boston, under the guidance of the sand blast. We have some buildings very dingy with age and smoke, which look almost new after treatment with a sand blast. In fact, one company added to their building this year a second section, which is just completed. In order to bring the old section in better harmony with the new building, they subjected it to the sand blast, and it looked cleaner and whiter than the new building just completed. If the concrete is of good material and properly made, why should there be objection to the sand blast.

MR. WATSON.—What kind of stone was it?

MR. LARNED.—New England limestone, I think.

MR. WATSON.—I would call Mr, Larned's attention to the fact that the most of the work we do is done on very new stone, most of it not more than two weeks old. We have cleaned a great deal of old stone in Toronto. I think if Mr. Larned would make a close examination he would find that that stone is without very much pit, whether natural or concrete stone.

MR. LARNED.—I should think it would be an advantage to have the surface of concrete for residental purposes somewhat irregular. We are seeking in the artificial concrete to avoid a uniform, monotonous surface, and if the sand blast will accomplish that, I say, let us try the sand blast.

MR. WATSON.—The difficulty is we are supplying stone to the architect, and the architect wants you to put in natural stone or imitate it exactly. Naturally, Mr. Larned's argument is a good one, but where the architect wants fine tooled stone, the sand blast cannot be used.

MEETING OF SECTION ON STREETS, SIDEWALKS AND FLOORS.

MR. L. B. WILLIAMS.—I would like to bring up the subject of single-coat sidewalks. I have put in several sidewalks and some cement floors in this way and would like to have an expression of opinion from the members.

MR. STANLEY.—For myself I have not put in any single-coat work at all. I do not know that I desire to do so with the material that we have on hand along the south shore of Lake Erie at Ashtabula, Ohio. In some places, it may be desirable to do this.

A few years ago, several gentlemen and myself investigated single-coat work and concluded it was best not to use it. It was proposed to use it in city work, but the idea was abandoned and we are still using two-coat work. The top coat is smooth, easy to keep clean, and the water passes off quickly. Snow and ice do not adhere to it nearly so strongly as they do to the single-coat work. Single-coat work has necessarily to be more or less rough, and is consequently not as slippery. That is why I favor it, but as to the wearing qualities and durability I have some doubts. The walks would not wear as even and it would be but a short time it seems to me, before the walks would be full of little pits.

MR. WILLIAM CONK.—I have had some experience in the cement business, especially on sidewalks, and I think the best piece of walk that I ever put down was a single-coat walk. I have had a great deal of trouble in various places with top coats not adhering to the base, but there are several reasons for that If you are careful not to let it get too dry, nor permit the top to get dusty or dirty, I think you will have no trouble with the two-coat work. But at the same time I think the one-coat work is the safest, for you can give a guarantee with that where you cannot with the two-coat work.

MR. WISELOGEL.—I have thought of the one-coat work quite considerably. We have one walk in Muskegon that was laid by a stone mason, who also concluded that he was a sidewalk builder.

He was determined not to have any more trouble with the top coat loosening, so he discarded the top coat entirely and put the cement in the base of the walk. He did not spend any more time in floating off the top and leveling it up than he would ordinarily with a smooth top, and while there are two cracks across his sixty-six-foot walk, they have been there to my knowledge ten years, and they have not changed any. I cannot say that that walk is worn any more than the walk on either side of it. That would show that one-coat work can be made to stay. Now, we have experienced some trouble in the two-coat work with top-lifting. Sometimes we could account for it and other times we could not. The fact that the top does come off is often due to carelessness of the workmen. I know of one case in which the top coat, after being down some time rang hollow, and on tearing it off it was found that when the top coat was being placed a workman had stepped on the wet earth at the side of the pavement and then on the concrete base of the pavement. The top coat naturally loosened where the dirt had been deposited.

In other cases I believe the concrete base of the walk was too dry when the top coat was placed, and of course the top came off.

I wish to ask another question. How long ought a walk be fenced before it is thrown open to the public? People are very anxious that you should build a walk, but you must not inconvenience them by fencing it off. We generally use what we call chicken wire, about three feet or five feet wide. In some sections you may perhaps go back there the next day or a bit later and you will find the wire down, people have passed over the walk and have made no impression whatever on the surface.

I believe that a great many broken walks are caused by people walking on them too soon after initial set. The constant tramping has shifted the foundation there, which perhaps may not have been tamped properly.

I see the entire trend of the sidewalk business is to make the pavement in blocks and cut the blocks through. In one case, one of our men put in a portion of a pavement without cutting through. As soon as I discovered what he was doing, I insisted

on him cutting the remainder of the walk clear through instead of only cutting the top. That was two years ago, and I must say I do not see any difference between that walk and the other. I cannot see but what it is just as solid. Of course, our soil does not hold water; it is porous; it is sand; so there is no danger from seeping.

MR. WILLIAM CONK.—I notice that at Asbury Park, New Jersey, they make a point of cutting the blocks through. I have watched their work, and I see that there is more upheaval of their work than there is in Long Branch, where we do not cut it at all. We simply mark the top coat, but leave the bottom coat uncut. I have never had one upheaval with that style of work.

I have had it craze and crack, but I found that by going over the surface with a trowel after the cement has partially set, and then using a print, does away with the crazing.

The main thing in our town is to get a good frost bottom. I generally put in from six to eight inches of cinders under the concrete, and I find that does away with any upheavel due to frost, but if we put the pavement on the natural clay or bottom the frost will raise it every time.

MR. WISELOGEL.—If there are others who do not cut their sidewalks through I would like to hear from them, because that is a matter of importance.

A MEMBER.—I have been making sidewalks for probably six years, and commenced by cutting through, but I have discarded that method entirely and have got a better job by only cutting the form. I have also discarded any artificial fill under the walk. I do not excavate, merely level the ground and put the pavement right on the clay. We have good solid clay and are not bothered with frost heaves. In some low spots where there is liable to be trouble from water, we cut a channel along the side of the walk and fill it with rubble, cobble stone, anything of that kind, lead a little trench off to one side, fill that with stone and let the water work off there. We have had better success that way than any other way.

MR. H. WEIDERHOLD.—I have had considerable experience in laying walks, and I find that the kind of walk necessary de-

pends largely on what soil you have. If you lay the work anywhere along the seashore where you have sand bottom, it is hardly necessary to put any foundation underneath, nor to cut your walks. It is only necessary to cut the top coat. If you do work on clay bottom or any bottom that absorbs a great deal of water, I find it essential to cut the concrete as well as the top coat, and invaribly you will have cracks if you do not cut them. The upheaval which we have to contend with is mainly from the expansion in the summer time. We have had a very costly experience due to upheaval in Philadelphia, by using a furnace slag concrete. Old furnace slag which has been lying out in the air for a considerable length of time is all right to use, but to use a new-made slag which has not gone through the process which it naturally goes through when exposed to the air, is a great detriment to our sidewalks. We used to get a slag which had been exposed to the air for years. We used that, and we never had any expansion during the summer. This old slag gave out and we were supplied with new slag, and what was the consequence? The second year after we had laid our walks they showed upheaval and came up at numerous places, and we had, if I remember correctly, in one year, over $10,000 worth of pavements to take up for the simple reason that we used new slag.

MR. JOHN EARLY.—Will cinders rot and decay under the walk?

MR. STANLEY.—Fine coal ashes as obtained from heating furnaces, power plants and under steam boilers will decompose; that is, they will soften so that they are not much better than clay. That has been our experience. Locomotive cinder ashes and clinkers, which are nearly all hard, mixed with small pieces of coke will not decompose. Of course, granulated slag, as now obtained from the furnaces, by treating the hot slag as it comes from the furnace with water, will not decompose.

MR. C. W. CALDWELL.—Eighteen inches of cinders in any northern city I consider a curse to a walk that is not well subdrained. I laid the walk around the post-office in Detroit. In places it is fifty-four feet wide. The specifications used on that work, which I suppose are government specifications, call for

four inches of sub-base, eight inches over all, and that walk has been down now eight or nine years. I consider it as good a walk as any I have ever walked over. I lay thousands and thousands of feet of walk every year on a heavy clay soil, as in my home town there is not a shovel of sand. Our specifications call for two inches of cinder drainage.

I believe very strongly in a four or six-inch well-drained cinder foundation and am firmly convinced that that is sufficient.

Suppose you dig a level trench fifteen inches deep and one hundred feet long in a heavy clay soil and fill in with a porous material like cinders. There is space in these cinders for ten times as much water as could have gotten in the original soil. The water will accumulate in there much more rapidly than it can escape under the curb, and a heavy frost coming when these conditions obtain will cause the water to freeze and possibly damage the walk.

I can see one case in which it will be advantageous to have a couple of inches of cinder foundation. If the surface of the walk is higher than the surface of the ground on either side, the water on the property side, if there is no porous foundation under the pavement, will have to rise and flow over the walk in order to reach the gutter. If, however, a shallow porous foundation is supplied the water will pass under the walk and flow off, or vice versa, where there is not good drainage.

MR. STANLEY.—From my own experience. I do like just enough of this porous material to grade up with. Of course we grade the ground space as level as it should be, and tamp it well. Then we use just enough of this porous material to have a good smooth ground base upon which to lay the walks. That is all we attempt to do now in Ashtabula. We run very frequently from a loose porous sand or gravel into the stickiest and heaviest kind of clay, and we find it almost impossible in many places to put in the porous material for a foundation and get a good drainage. Of course, it can be done, but with the price we get we cannot afford to do it. We simply put the walks directly on the ground, and we are having fully as good success as we used to when we put in the foundation.

MR. WILLIAM CONK.—I experimented on a sidewalk I put down around my house. I dug out about seventy-five feet of

it and put in four inches of cinders for frost protection. The other twenty-five feet I put directly on the natural clay or bottom. Everytime it freezes that twenty-five feet which rests on the clay will rise about one and one-half inches higher than the other part of the walk. With the four inches of cinders it does not rise at all. So I am satisfied that four inches is just as good as twelve inches, as far as frost goes.

MR. STANLEY.—Were they ashes or locomotive cinders?

MR. WILLIAM CONK.—They are gas-house cinders and are coarse. I find that the coarse cinders are better than the fine cinders for the first bottom.

MR. STANLEY.—I would like to bring up the question of fencing during construction. We recommend using a wooden slat fence with wooden stakes. We found that the wooden stakes were soon broken, that it was difficult to keep enough on hand, and in moving about they occupied a good deal of space; so this last season I commenced using iron stakes. I found that an iron stake four feet long with a little hook at the top turned back to hang the wire on, was the most convenient stake to use. In many cases it could be pushed right into the ground, and if it became bent could be straightened easily. The cost of these stakes was about fifteen cents apiece. We had perhaps eight, ten or a dozen longer ones, some of them five feet long, to use where the ground is uneven, places where shorter ones will not answer the purpose. The fence is always hung from the top. Then, too, if you want to fasten top and bottom you can run through the mesh and drive it, and hook the top on. There are a great many advantages we found in using that kind of stake. If there are any here who have had experience with iron stakes, we should be glad to hear from them.

MR. G. F. LILLIE.—I have never had any experience with iron stakes, but I have a canvas six feet wide and seventy-five feet long, which we use in fencing our walk. If the sun is shining very strong we just lay the canvas on the walk as fast as we complete it, and keep the canvas wet. I suppose we have all had a walk damaged by rain. The first time I got my canvas was a year ago last summer when I was building a ten-foot walk. There came up a quick thunder shower. We had about two

hundred feet of that walk laid over which we spread the canvas. I saved the cost of that canvas the first time I used it.

MR. JOHN DOWNS.—In reference to fencing and iron stakes I have had a little experience. I find that it is economy to use iron instead of wood, and economy to use wire, whether you use canvas or not. In the little town where I live, Fort Madison, there is a factory from which I get scrap iron stakes for less than three cents apiece. The Gas Company has lots of scrap iron pipe of various lengths, and I get fencing stakes for less than half a cent a running foot.

MR. C. M. MAYNARD.—I would like to speak of a feature in our town that I have not seen touched on yet; and while it may seem rather out of order in a way, yet it seems to be practical. I am from the anthracite region, where there is a great deal of anthracite cinders from boilers, and while it is advocated in all the papers to use cinders for floors and roofs, we have found that we make a fairly good sidewalk, for the reason that the wear is all on the top and not in the middle. We use ashes for drainage purposes and about three and a half to four inches of cinder concrete mixed 1 to 6 as the material comes from the furnace, and then a top coating of cement, such as you use. We find that this makes a fairly good walk, for the reason that when it is thoroughly tamped and pressed, it obtains an intense hardness. If it is sufficiently strong for floors and roofs it should be sufficiently strong for sidewalks, and the wear coming entirely upon the top, it presents entirely as good an appearance as any other sidewalk. I offer this as a little out of the ordinary, because, where cinders can be obtained they are easily handled. You can shovel them from the dump into the wagon, unload them, place and tamp them much easier than you can any gravel or crushed stone.

MR. STANLEY.—If I remember rightly, I have seen statements by concrete experts and engineers that cinder concrete is about half the strength of good gravel concrete. Of course there might be localities where this can be used.

A MEMBER.—How deep does the frost go there?

MR. C. M. MAYNARD.—The maximum depth for an extreme temperature is about two feet.

MR. G. E. LILLIE.—Our city ordinance calls for a sixteen-inch curb on the main street, eight inches thick and sixty inches deep, below the bottom of the walk. That will be twenty inches from the top of the walk. I would like to have a little information on curbs in connection with cement walks, if anybody will give it.

MR. STANLEY.—Most of the specifications for such curbing, at least, in our cities call for a gravel base and an open sewer pipe underdrain, that is, joints not cemented. This takes off the water and seems to me to be the only proper way of laying any curb, whether it be a gutter curb or a street curb, as there would be no danger of upheaval. Of course, civil engineers have charge of such work usually and make specifications, but that is the way they are generally made out. It is the practice, I guess, generally in most of our large cities, unless the ground is very porous and has a drainage of its own, when it is not done.

MR. H. S. HIBBARD.—I hardly recognize your idea as to the necessity of draining the curb and not the walk.

MR. STANLEY.—Of course there is a difference in the two, a difference in the position. A curb is put next to a pavement, and pavements are usually well drained. They necessarily should be. We will admit, probably, all of us, that if a porous material is put in for a foundation, if it is carefully drained, it is an advantage to a walk. But it is such an expense to do this that the property owner does not want to pay for it. And then, another thing, most of our cities do not have any specifications or any means of enforcing specifications. That being a fact, it is next to an impossibility to drain our sidewalks. Perhaps it may be done in some of the larger cities, Boston and St. Louis, where they have an inspector. We worked in the City of Cleveland one year, and put in 4,500 square feet of walk in front of an estate in which we had an interest. The very first thing we had to do there was to deposit $100.00 with the City Inspector, and the inspectors were on that work nearly every day to see how we were doing it. That $100.00 was to remain there one year. Where they enforce specifications in that manner they get good walks. There was no drainage under this walk, and it was on

clay soil in a very bad place. We built that walk with gravel from the creek and took bank sand from the knolls on the estate, and mixed it with the finer gravel which was screened out of the coarse. The sand knolls were taken down and used for mortar sand. The City Inspector told me a year after, that the walk was sound, so you see with such an experience as that, we can speak with confidence. In regard to the drainage of walks, it is almost impossible, where they cannot force rigid inspection.

CONCRETE BLOCKS.

By Harmon H. Rice.

Because I believe that concrete block construction presents a representative style of architecture, typical of that spirit of independent enterprise characteristic of American progress, and because Europe, Asia, Africa and the islands of the sea are looking to the States for light upon this industry, I characterize the conduct of our business, or, if you please, the practice of our profession, as the National Game, believing that in the play of the Diamond we shall find an interesting and instructive parallel to the opportunities and responsibilities of co-workers in the domain of concrete blocks.

In the pitcher's box stands the stalwart blockmaker, in stature well proportioned, by nature a good mixer, through systematic training, always in good form. There are too many smart men, and too few able men filling this position. The time has passed when the pitcher may, with clever curves, deceive the watchful batter's eye. The battery of wood, clay and stone has learned to know these curves. The victory of the day is to him who, with perfect mastery of self and with thorough knowledge of the field, delivers a ball which is strong, swift and true—a thing of beauty and a winner forever. In the throwing of such a ball there is successful introduction, there is permanent and increasing patronage, there is profit, and there is public favor. Uniform excellence rather than spasmodic brilliancy counts on the score card.

The superintendent takes the catcher's place, because from this position the personal equation can never be eliminated. Whatever may with truth be said for the efficacy of modern applications adapted to playing the game, however completely the catcher may be equipped with mask, mitt and shield, it is in the end the man behind the bat who saves the day. It is his quick eye, supported by a studied knowledge of the field, an intimate acquaintance with the players, and an intuitive recognition of the vulnerable points of the opposition, which brings

his adversaries to shame. It is he who must watch the field and the bases, to the end that he may ever support the play and co-operate with the plans of the several players.

The machine manufacturer we put on first base, because in those olden days when we "chose up sides" he who came first usually claimed this position. So, by precedence in the field, it goes to the maker of machines. When he first took the place he had not that full quota of players which we find to-day. He had some sorry days before the game was popularized. But he was a persistent player. And then there came a time when some of those on the bleachers said that the first baseman drew higher pay than the pitcher, but that day, too, has passed, for the game draws greater crowds and the pitcher's skill is cheered by audiences who have learned to know its merits and to watch the ball. And yet does not our first baseman rest too easily upon his laurels; does he not rely too much on the pitcher's skill and the catcher's diligence to increase the interest of the game? Rank imposes obligation, and our first baseman may not shirk the responsibilities incident to his birthright.

On second base we have the cement manufacturer. He plays well, though at times lacking enthusiasm. But he has many rival interests, with his golf and his cricket and other games which he learned in the land of his birth. And yet he is, withal, a dependable player, a player of quality, a player who always stands the test. In the changes of climate incident to the migration of the club, in freezing and in boiling weather, his tenacious qualities prevent his disintegration. His strength is so great that he does not become distorted, even when the umpire's words are thrown at him. In emotion he is paradoxical, inasmuch as his heart strings have been torn asunder by one-tenth the grief necessary to crush him.

The mason is on third base, where careful, accurate and uniformly excellent work is required. Too often has a wild throw from third enabled the runner to land safe on the home plate. Perhaps it is not too much to say that the slovenly mason's work on third base has lost more games than the careless work of any other single player. He has regarded our national game with less favor than those games handed down

to the present generation from the ancients of Egypt and Assyria. His longer training in the games of the Orient has made his hand cunning to their play, and he has imagined that in seeking their perpetuity he has insured more continuous activity for himself.

Our salesman shortstop is so optimistic concerning ultimate success of the game that many regard him as visionary. And yet to him is due the credit of earnest and persistent work toward the realization of his visions. He has gone into waste places to introduce the game, by his intimate knowledge of its rules he has taught others to play without error, by his consideration for the ultimate well being of his associates he has silenced the tongue of slander, by his energy and fair dealing he has gained the respect of the opposition, while his good counsel has enabled his colleagues to make plays of such unexpected quality that the grand stand rocks with applause. In his success there are no secrets save honest, loyal and untiring zeal. He has studied the game well, he knows the men, he keeps his eye on the ball, and he enjoys the confidence of his fellow players, of his opponents and of his umpire.

The architect is in the left field, and it is only when the pitcher throws carelessly or a mighty man comes to bat that the ball reaches him. Hence he has much time to watch the exertion of other players, and he seems to be growing a bit restless and anxious to come closer in the game. Time was not long ago when he refused to play, but as he sat on the bleachers and fanned himself with his hat he could but observe the intrinsic interest of the game and the ever increasing skill of its players. He is now one of us. Let us welcome him and applaud heartily when he plays well.

The contractor in the right field takes an exceedingly practical view of our game. To the vox populi his ear is ever open. He is a good player, but ready to stay with us or to leave us as the crowd may applaud or deride. So he keeps one eye on the grand stand, and if handkerchiefs be waved and hats flung high his energies rise to mighty plays. With the increasing popularity of the game, it is hoped he will become more settled in his appreciation of its merits.

To our good friend, the journalist, we give center field, and in it he does valiant work. The shouts and plaudits of the throng are dear to him, and he adds greatly to the joy of all by those spectacular plays which ring encomium from the very boards on which spectators sit. He may not know all about the game, but he is powerful in talk, and he keeps up our spirits on days when things go badly. It is his wide reputation which has added so largely to the gate receipts, and sometimes, when crowds are not what they should be, the captain excuses him for the afternoon to go down among the newspaper offices and fill the galleys with the history of our past triumphs, the story of our present greatness, the prophecy of our future magnificence.

The owner of the building in which concrete blocks shall go is our umpire. To win from him the coveted decision it is not enough that one should play well—he must play at his best. The umpire knows the game better than do some of its players. To attempt deception is to invite his displeasure. Honest, manly, fair play counts with him. He does not greatly mind the so-called brilliant plays. The player who wins his enduring approval is that one who is ever in form, who day in and day out strictly observes the rules of the game, who avoids errors as a plague, and who invaribly plays a good game.

If we are in the game, let us play it as well as we are able. Let each man, while performing to the utmost limit of his ability the duties of his particular position, never fail to render with heart and hand that support to his fellow-players without which the game cannot be a success. In community of interest, and unity of endeavor, lies the ultimate success of the nine.

In any discussion of concrete block construction, the basis of consideration is form. As to the importance of form, I am indebted to Mr. George Iles for a most forceful illustration. In his new book, "Inventors at Work," he tells of an experiment made in Canada during very severe winter weather. A piece of ice was fashioned to the form of a lens, and so effectually did it focus the sun's rays that paper was burned and wood was charred in the same manner as though an ordinary reading glass had been used. Thus is shown the paramount importance of adapting the form of structural material to the service required.

The plasticity of concrete enables it to be molded into units of greater utility than those of any other building material known to mankind. Without attempting to speak of the many forms on the market to-day, it may be said in respect to all that the air space in the wall gives to block construction its distinctive advantage. Too readily do we allow minor considerations to rob us of an adequate air space, and too careless are we of the encroachments of those building departments which reduce it to a point which strips the concrete block of its essential points of superiority. There is, I hold, no excuse for making blocks of so inferior quality that the percentage of air space need fell below that requisite to the preservation of fire-proof, frost-proof, moisture-proof, heat-retaining and heat-resisting walls.

But to maintain this high standard of quality the ingredients must be right, and they must be used in such relative proportions that voids will be eliminated, and maximum strength and density will result. It is the application of scientific principles of concrete work rather than the haphazard use of a large proportion of cement that makes for quality.

The thorough manipulation of the mass is more essential in block manufacture than in any other branch of concrete engineering. Where defective blocks have been produced investigation has generally disclosed faulty mixing. Hand mixing is seldom sufficiently thorough, while operators in the smaller towns have been unable to bear the expense of installing and operating power machines of standard type. The present season, however, brings to the relief of such operators a unique hand mixer of adequate capacity which mixes thoroughly and leaves no excuse for clinging to the shovel and hoe of former days.

Of curing I would that the time permitted me to speak exhaustively. Herein lies success. Drying is not curing. Ageing is not curing. Curing is a scientific process by which a plastic body of concrete is converted into an enduring stone-like unit able to honorably bear the duty for which it is designed.

It is not in a spirit of criticism that I advocate the application to concrete block manufacture of scientific principles of concrete engineering. Rather it is because I thoroughly believe in the ultimate ascendancy of this type of building, and because a duty

is upon me to urge universal maintenance of the highest standard of quality in which will to-morrow be known as the great American industry. Great because it reaches the very heart of our people in the construction of strong, durable, comfortable and sightly homes at moderate cost. Great because it reaches from the metropolis to the most remote hamlet of the nation. Great because it affords that opportunity which without it is withheld of building enduring habitations in the desert, warm abodes in the north, cool houses in the south, dry houses in the valley by the great river, fireproof homes beyond the highways of hose carts.

I know full well that I have but touched the edge of that fertile field wherein the uses of concrete blocks are ripening for the harvest. I know full well of their efficacy in the ornate palaces of the rich, and in the imposing edifices of county and of state. And yet it seems to me when the end is told it will be known that concrete block construction finds its ideal application in the homes of Americans, and that in those homes it will find an ultimate glory over which the lofty scraper of the sky may cast no dimming shadow.

If we go not from hence with a fuller appreciation of the dignity of our calling, with a higher reward for the merits of our merchandise, and with a firmer resolution to lift the concrete block industry to that high place of public favor to which it is rightly entitled, our meeting together shall have been of no avail.

"Not how cheap, but how good, can concrete blocks be made," is the battle cry with which the ranks of this association must resound as we go from this convention hall to wage ceaseless warfare in a campaign which shall not devastate the enemy's land, but shall beautify and enrich and build up the country through which we march to victory.

DISCUSSION.

Mr. Spencer B. Newberry.—I want to repeat and emphasize some things that we all know, or ought to know; some things that every year, every month, every day, must bring out more clearly and more decidedly, certain things that we must keep in mind, if we are going to make a success of this business, and going to make concrete block construction what it ought to be in the way of popularity, and what it must be in the way of quality.

In the first place, with regard to materials, there are a great many of you who are using inferior material without stopping to think that very likely you have available at the same cost, or perhaps cheaper, something that is very much better. I have found very few cement users who realize what a vast difference there is between sand and gravel. Sand is a mean material to use. Fine sand is nearly a worthless material. I have taken some sand mixed fine and coarse, but mostly rather fine, with which I made briquettes, one of cement to five of sand. Then I made up similar briquettes of a bank gravel which apparently contained no sand but did contain some fine gravel. At the age of seven days those of sand broke at 150 pounds per square inch, while those made of gravel broke at 655 pounds, or in other words those made of gravel were four times as strong as those made with sand. A great many block makers are using sand and they hardly realize probably, that even if they used one of cement to three of that sand, their blocks would be very much weaker, and far from as good as they would be if they used gravel mixed with a little sand in the proportion of one to six.

It is absolutely demonstrated by repeated experiments that a mixture of one part of cement to three parts of sand is strengthened by adding five parts of gravel; that is, mixture of one part of cement to three parts of sand is no better than one containing one part of cement to eight parts of sand and gravel. Why?

Just think a moment. Suppose you have a cubic foot box, and you filled that with a mortar made of cement and sand, and allowed that block to harden. It would have a certain crushing strength, would it not, whatever that might be. It might be 1,000 pounds to the square inch. Now, suppose you took that cubic foot box full of mortar and took out half of that sand and replaced it by boulders as big as cocoanuts or apples; rammed them in thoroughly; would that weaken it any? By no means. It is the best thing that we could do, we could not make a concrete as strong as those boulders themselves. They would merely take up some of the room and contribute some of their strength to that mass. It is the same way when we add the coarse material to the concrete. We are taking up room and diminishing the quantity of mortar and cement required without weakening it in the slightest degree In fact, we are strengthening it, and the same time gradually cutting down the amount of cement. With cement and sand and gravel, or cement and sand and broken stone we can make with 10 per cent of cement just as good a concrete as you can make with cement and sand alone with 25 per cent cement.

We must keep these things in mind. A great many cement makers are using a facing made of cement and fine sand, and I have been asked why the soft surface of the blocks made in this way does not harden. It is simply because it is a soft surface, and because the body of the block contains a large amount of gravel or coarse material, and is actually a very much richer mixture, so far as all effect is concerned, than that face consisting of cement and fine sand. You cannot make a good concrete; you cannot make a hard mixture out of cement and fine sand, unless you make the proportion of cement very high indeed.

What is the object of using this fine material? To get a smooth surface, under the mistaken notion that architects want it or that the public wants it. Possibly a large part of the public does; but, if so, we ought to educate them out of that notion.

Some time ago my attention was called to some columns of limestone which supported the roof of the piazza of a hotel. Those columns had been there probably sixty years or more, and

they are very much weather-worn. They are a fossiliferous limestone, a stone full of fossils, and concretions, and showing variety of color and variety of surface, pink and buff and other colored spots against the grey ground. That is what we want. If you cement manufacturers or cement workers can make that, that is what the architects are looking for; something that has life; something that has a variety of surface.

I presume many of you have seen the samples that were exhibited last year at Milwaukee of brush-finished concrete, in which coarse gravel with a variety of colors is used, and after the mass is set for a day, it is gone over with a soft wire brush, and the surplus cement removed. The coarse particles come out. Those are the surfaces that give pleasure to an architect, but a neat cement surface, or an even cement and sand surface, with a smooth lusterless appearance, is dead and lifeless, and the architects dislike it, and that is one reason why they are reluctant to adopt what we have to offer them.

I think it is a mistaken notion to use fine material for facing. I think it is a mistaken notion to use facing at all, because I think it is more bother than it is worth, and still I know there are a great many excellent judges of concrete work who will not agree with me there, but I would rather make my concrete blocks out of just as coarse material as I can get, and then if possible secure that grain and variety to the surface which will give it a certain amount of life. As far as the strength and quality is concerned, I tried to bring out clearly the point that the coarser our material, and the less fine stuff it has in it, up to a reasonable point, the better and stronger the concrete will be.

I am telling you things that you know already, and I must apologize if I make myself tiresome, but there is one matter that is of the greatest importance, and I feel I must take this opportunity to dwell upon and emphasize as strongly as I can, and that is the amount of water used in mixing. There is more misunderstanding about this than perhaps anything else connected with concrete. A great many people believe that if you make blocks with very little water—make them dry—you can sprinkle them afterwards, and the water that you put on the outside after the block is made, will have the same effect on hardening the block

as if it were put in the mixture at the start. Nothing is further from the truth. Suppose you dig a hole in the ground and pile up the sand and gravel that you dig out, and then you try to put that sand and gravel back into the hole. You can pound it all day, and you can never get it back again, not in the dry state. But if you turn the hose on it, you can wash it back into place. That is what is done in filling up excavations in the street after sewers have been excavated. Why? Simply because the water flushes the material, to allow the grains to flow and mingle with one another, and thus allow the mass to assume its greatest possible density. That is exactly the effect of water in mixing concrete. It is to give density. And the greater the density, as was brought out very fully in the paper discussed yesterday, the greater the strength, and a little more density gives us a whole lot more strength. That we must keep in mind. If we make our blocks or our concrete work of any kind dry, it will always be loose and porous. We must always have water enough there to let it settle down in place and for the particles to get where they belong. If we make our material dry and them attempt to sprinkle it afterwards, we do not change the chemical condition, and the water we add there is not needed. Stop and think a minute. Portland cement takes up in hardening, 10 or 12 per cent of its weight in water, and not more, even after a year. Now, if we have a 1 to 5 mixture, taking up 12 per cent we have there only 2 per cent of water in terms of the weight of the whole quantity of material required. That is, the concrete requires for the hardening of the cement—a 1 to 5 concrete—only 2 per cent water. The dryest mixture 1 to 5 will contain 8 per cent of water; you cannot make a block with less; therefore, you have three times as much water there at the start, even in dry mixture, as the cement will take up. It is not then that our blocks which are made dry, do not contain enough water to retain the cement. The reason the blocks are poor is that they do not contain enough water to wash the material together and make it dense.

But it is objected, if we put in a large amount of water, we cannot take the blocks at once out of the mold. Indeed you cannot. If you strike the point where the water is the maximum,

still permitting the blocks to be removed at once from the mold, you will get a good block, and just about as good as you can get in any other way. A damp tamped block, as I call it, must be made wet enough to be plastic, so that when these side plates are removed, the block shows a slight tendency to sag, and is in the consistency of a stiff jelly. It need not sag perceptibly, but must be just on the point of sagging and it must be so wet that the parts will just leave the mold and almost stick. If you will do that you will get a block that will ring when you strike it, like metal, and will be sound and strong and free from all the objections that are made to concrete blocks as ordinarily made. If, however, you work the blocks dry, you can get them out of the molds quicker. You can turn out more in a day, and save cost of labor, but they will always be loose and porous and earthy and crumbly. Use just as much water as you can and still get the blocks at once out of the mold.

Then there is another thing, the effect on the color. A wet block is always very much lighter in color than the dry one, and the variation in color of the blocks comes mostly from variation in the proportion of water. If you will watch that carefully, see if it is not so. The real way to do, of course, is to measure the water. You cannot measure it for all times, as your material will vary in moisture as they come in, but measure it and set your measure for a certain day, or a certain part of the day, and stick to that, so that every batch will be like every other.

Now, one word more about the appearance of blocks. We are going to have considerable discussion on that, and some very valuable papers will be read on that subject. I merely want to say from the point of view of the concrete block maker, that in my judgment we should do everything we can to discourage the use of the rock-faced block. It is an ugly thing, at best, because it is a fraud and an imitation. A rock-faced stone is the result of an actual treatment of the stone with tools, and no two rock-faced stones are alike. There is a variety to the surface. But even when we use several rock-faced molds and make our blocks of different patterns, and mix them up as well as we can, we shall always find in the building places where two or three or

four of them of exactly the same face from the same mold, come together, and that is exceedingly noticeable.

The most pleasing blocks that I have ever seen for building purposes in buildings and residences, are the brush applied, and several of the makers of block machines turn out very pretty brush-applied plates. That is, they have a plain or a fluted border and a flat pebbled surface. They are not an imitation of anything, and there is no monotony or sameness about them, and they do make an exceedingly pretty building. In our factory construction, we are building a large cement factory at Dixon, Illinois, and we made 90,000 blocks last fall of this brush-applied surface for all the factory buildings, and I may say right here that it is the only material for factory construction. I cannot see how any manufacturer can want anything else. The blocks cost us, made on the ground from our own gravel, less than half what common brick would cost, and we can keep a force of men busy at other things, and when they have no work to do, set them to making blocks, and in that way always have blocks ready for factory construction. And another thing, if these blocks are laid up in lime mortar, if any change is desired, windows or openings or change of the building, there is the material always available and perfectly good for use over again. It is an ideal material for factory construction.

For residence purposes, the introduction of concrete blocks is going on steadily, but after all, rather slowly, and I think we must feel that it is rather disappointing that more people do not adopt it for residence purposes. Why in the world should such a multitude of frame buildings be going up still, with the demonstrations that have been made again and again that concrete buildings are as cheap and infinitely better and very much more attractive. Why should so many stone and brick buildings be put up, when we can give them something at least as good at one-half or one-quarter the cost? The reason is simply that people are prejudiced against the material for lack of beauty of design. You will all perhaps be interested to know in this connection that the association of Portland Cement Manufacturers has offered a series of prizes for designs of moderate priced houses to be built of concrete. Of course they will chiefly be designs of concrete

block houses. There are prizes for first and second and third awards, and also for honorable mention, for designs of houses of four rooms, six rooms and eight rooms. There was a strong tendency at the meeting when that was argued, to try and include more expensive houses, but some of us objected very strongly to that, and we said, that is not what is needed. A man who wants to put up a $10,000 house can employ an architect and have him put him up a reinforced concrete building of Spanish or Mission style, and get artistic effects, but what is wanted at the present time is a number of good designs which country builders throughout the United States can take and show to customers when they are considering the building of a small dwelling, and are considering the use of concrete for that purpose. There are a multitude of customers who would adopt concrete buildings at once if they could see something tolerable, even, in the way of design. Now, what we want to do in this award is to instruct the architects throughout the country and get them to give us a great number of good designs which have practical character and economy and beauty, which can be published in pamphlet form and circulated throughout the country. I believe that will do more than everything else put together to popularize and introduce concrete block construction for dwelling purposes.

MR. A. N. PIERSON.—Mr. Newberry, at what price do you figure the cement when you do work so cheaply. What were the size, weight and cost of these blocks?

MR. NEWBERRY.—I presume Mr. Pierson refers to the factory construction that I mentioned. Cement was charged at just as high a price as it would be sold as to any outside customer. It costs about a dollar and a half a barrel on the work, and the blocks were made sixteen inches long, though of course not any more expensive on that account, in a sixteen-inch block machine, or on several of them, and cost about seven and one-half cents to make, using one to five bank gravel. This is not the cost erected, but is simply the cost of the material and labor in making a sixteen-inch block eight inches wide.

MR. PIERSON.—Do you know the weight of that block?

MR. NEWBERRY.—I do not know just exactly, but I think that the block weighed about forty-five pounds.

MR. HAMMOND.—They weigh about forty-five to forty-eight pounds.

MR. HOLDEN.—I would like to ask Mr. Newberry in regard to the use of hydrated lime. I think I have read in some of his papers an advocation of the use of certain kinds of hydrated lime in connection with cement. Am I right? What is the advantage of that, may I ask?

MR. NEWBERRY.—I think the addition of hydrate lime improves the appearance of the block and improves to some extent their quality, making them denser. You can replace one-quarter or one-third of cement by hydrate lime without any loss of strength, and with the addition of hydrate lime, if you use the additional amount of cement and add one-third or one-quarter its weight of hydrate lime, you get a more plastic block, which is whiter and smoother in appearance, and more waterproof, as it is less permeable by water. But I may say that in the concrete block factory in which we are interested we have, within the last year, given up the use of hydrate lime, for the reason that with the waterproof compound which we have developed and have on the market we can accomplish better and cheaper what we were trying to do with the hydrate lime.

MR. HOLDEN.—Do you consider the action of hydrate lime similar to that of cement, or is the chemical action different?

MR. NEWBERRY.—It is different in this way, that there is no hardening effect on hydrate of lime as long as the block is kept moist. Lime hardens only by drying, whereas cement hardens while kept moist, and does not harden when it is dry. The effect of the hydrate is to fill up the voids, and in that way, so far as I can see, the effect is exactly the same as any other material. You can grind sand slowly with Portland cement to great fineness and get improved strength. And material which will aid in filling the voids and making a more dense mass, would increase the strength and make the cement go further. It is similar to the sand cement which you know about on the market, which is simply cement and sand ground together to great fineness. A given amount of cement used in that way goes a good deal further and will make more concrete of a given strength. It is not, however, been generally found to be a good commercial proposition.

A MEMBER.—Do you recommend waterproofing in the blocks for that factory, and is the proportion 1 to 5?

MR. NEWBERRY.—The proportion is 1 to 5, and waterproofing is done on this work throughout whenever it is necessary. Of course on some of the buildings where the penetration of water is not of the slightest consequence, the waterproofing compound is omitted.

MR. J. R. GILL.—I would like to hear about that experiment in which you made a briquette of pure gravel. In that case you made no attempt to get absolute density, and yet you get a degree of strength.

MR. NEWBERRY.—I said that that gravel contains practically no sand, but a considerable proportion of fine gravel. That is, it was a mixture of fine and coarse, down to the fineness of ordinary sand. It was material that gave the maximum density, and the reason the strength was so great was that the gravel was in just the right condition to give an extremely high density; and if you will perform experiments on the weight per cubic feet of gravelly material, you will find that, given a certain amount of pebbles, it requires an addition of a very small amount of fine material to bring it to the maximum weight per cubic foot.

MR. STANLEY.—Mr. Newberry, what size grains should be considered sand.

MR. NEWBERRY.—I do not think that I could be asked a harder question than that; but from the commercial point of view I think it is generally customary to classify as sand everything that passes a quarter-inch sieve, and classify as gravel and pebbles what remains on it, though, of course, there is no distinction between the two.

MR. M. C. ROBINSON.—When I first started in the block business three years ago, I made a sand block and found I could not make enough to pay me. After reading Mr. Newberry's pamphlet, I made two classes of brick, one of 1 to 4 of sand, and one of 1:2:6 sand and gravel, and I sold them seven cents apiece less, and from that day to this I have found it a profitable venture.

MR. M. S. DANIELS.—I would like to ask Mr. Newberry whether when it is impossible to secure gravel he recommends the use of crushed screenings.

MR. NEWBERRY.—I will answer that question as well as I can, and say that in my judgment limestone screenings are just as good as sand and gravel, if the screenings are of good quality. Limestone is, however, a very variable material. Much of it is soft and shaly, and makes poor concrete. A hard, sharp limestone makes an excellent concrete. But we must remember, as Mr. Larned said yesterday, that limestone from the crusher, commonly called "run off the crusher" is excellent material, and limestone screenings will vary greatly; much of the screenings on the market contain too much fine stuff. There is no doubt about that. Then, again, we must not let that carry us too far, because you do want a small excess of the fine material present in order to give you a concrete which has a good surface, to help fill up the voids on the surface and to give you a clean-looking job. Probably you want present a little more fine material than is necessary for greater density. It is a thing, then, that ought to be experimented with. If I had a supply of limestone screenings to use for concrete blocks, I would try and see whether I could improve the weight per cubic foot, and improve the quality of the blocks that much by screening out some of the fine material, or by adding some of the fine material, and get it into the best possible condition for that purpose. But as a material, I can say it is generally agreed that for concrete crushed limestone is at least equal to gravel and sand.

I believe that much of the dampness that is noticeable in concrete block buildings could be prevented if an effort was made to secure proper ventilation. It would be a very simple matter to provide a circulation of air through the hollow space in the wall.

I should think that ventilation through the blocks would unquestionably do away largely with the dampness and penetration of moisture. Still it is within the reach of everybody to make a block through which the moisture will not penetrate, and for my part I would a great deal rather be on the safe side. Unquestionably a current of air through the building would do very much to prevent dampness.

MR. HOTCHKISS.—If you make an impervious block is it not possible that you will have condensation regardless of whether there is any moisture coming through the block or not?

MR. NEWBERRY.—That should not be the case, because the blocks should not be water-tight, but merely to be so slow in penetration of moisture, that any moisture that falls on the outside will penetrate only a short distance and will evaporate quickly. If we lined our rooms with glass plates, or with terra cotta tile, we should certainly have sweating and condensation on the inside, because they would be non-porous, and the moisture deposited on the inside could not be absorbed and carried away. If we make them so tight that the moisture will only very slowly evaporate, it will never get through to the inside from the outside during a long run. But we do want a certain amount of circulation of air through these blocks, and we will always get it with any general method of cement, or concrete construction, because they are always to some extent porous.

MR. WISELOGEL.—Before we leave the subject of the use of hydrated lime in concrete, I would like to state a rather peculiar experience that I have had, thinking, perhaps, that some other person here has had a similar experience and we might get an explanation. We were mixing concrete 4 to 1, that is, three parts of sand, one part of marble dust and about 10 per cent of hydrated lime. We were using an upright mixer with plows, and at times we would get what I termed a hot batch, when the concrete as it came out would be actually hot, and when molded into a block it would turn almost white, and crumble. I have never been able to find a cause. I have tried a great many experiments with the different matrials used and was unable to find the cause.

MR. NEWBERRY.—I should thing it must be that the hydrate of lime was imperfectly slacked. If any heating took place, it shows there was unslacked lime present.

MR. C. W. CADWELL.—I believe almost everyone who handles cement has noticed the fact that on unloading a car some sacks of cement may be quite warm while others will be cold. That has been my experience with quite a number of different classes of cement: I had in mind a car of cement that was brought in, and we immediately telegraphed to a representative of the manufacturers to examine it. Some of this cement was mixed to a sloppy consistency but nevertheless it set so

quickly that it was impossible to obtain a good finish. The next day that was so soft that we could not walk on it. In fact we had to keep that fence up for four or five days before it could be used. That is just as hard a walk now as any of the others. I do not know the cause of this action, nor could I find anyone who could give me a satisfactory explanation.

PRESIDENT HUMPHREY.—Generally speaking, a slow hardening cement is preferable for most work. There are conditions under which quick setting cements are desirable, as for work under water. Then there is a class of cement which is made and is perfectly good, but in which the relation of the chemical ingredients is such that the cement sets very quickly, and those cements have the peculiarity of perhaps getting an initial set in a very short time, some of them setting so quickly that a condition results that is known as "flashing." If that cement is worked until the "flash" or tendency to set has apparently ceased, then the cement becomes very soft and plastic, and the rate of hardening is very materially increased. So that we have a condition that is very similar to that described by the gentleman who has just spoken, the cement in time obtains a hardness just as good as the original material. You must bear in mind that the question of hardening of cement is purely a chemical one; that the powder that is delivered to you in sacks or bags is an unstable chemical compound. It can only become stable by the acquirement of moisture, either as you add it to it in the process of mixing, or through absorption of moisture from the air during storage. Until the affinity or the thirst of the material for water is satisfied, that material will be unstable, and the proportions of the various ingredients are such that the appetite varies. Some cements are more hungry for water than others, but when that hunger is satisfied, if you break up those crystals you destroy the strength of that material to the extent to which you break up the crystals. If the concrete is disturbed after crystallization is entirely completed, then all the life and strength are taken from the material.

There is another point I would state. In your mixture of sand and stone, or whatever you may want to bind together with cement, a very large percentage of the cement will remain in the

inactive for a long period of time, the process of hardening never ceases. The very simple experiment of grinding up a piece of hardened material, mixing it again with water, and molding it into a form, shows in the extremely slow process of hardening that all the cement had not been acted on. It takes a long time, but that material will eventually acquire strength, showing that there is still in that concrete some active parts which will still bind the mass together.

MR. NEWBERRY.—I do not feel like taking any more time, but I would say that this subject of cement becoming quick-setting is the most pressing and bothersome that the cement manufacturer has to meet. For the most part we say that preponderance is on the side of the cement manufacturer, because his cement, which is bad at the start, will keep good if he keeps it long enough. But there is one exception to that, and that is cement which is perfectly good and slow setting when it is made is liable, on storage, to become quick setting, and that change sometimes takes place very suddenly. Nobody knows why but it seems to be connected with the temperature, and one thing is certain, it happens always in warm weather, and it happens always when the cement is stored in a warm storehouse. If we get a sack of that quick-setting cement, and put it in a cellar and leave it a few hours, it is just as slow-setting as it was before.

Of course, the natural thing to do is to telegraph to the manufacturer, and tell him the cement is poor, and tell him to take it away at his own expense. But there is one thing you can do, if that would inconvenience you and you want to get the work done, put in a little lime. Professor Carpenter has worked that out very carefully. Two per cent of hydrate lime, or the ordinary thoroughly slacked lime mixed with a quick-setting cement, will make it slow-setting, and you can use it on the work, with perfect success. If anybody can throw light on the reason that cement which is slow-setting becomes quick-setting on storage, it will be worth a great deal to the manufacturer. Up to the present time the reason has not been discovered.

MR. E. N. BARKER.—I should like to ask Mr. Newberry if it is not entirely practical to manufacture a cement which will be

consistently slow-setting and permits hardening? In other words, a cement which shall, in a twenty-four hour test, show a tensile strength of upwards of 400 pounds. If it is practical to manufacture such a cement, it means a lot, I should think, not only in the manufacture of blocks and bricks, but in reinforced concrete construction and in cheaper construction.

MR. NEWBERRY.—Do you mean a cement which would always be slow-setting?

MR. BARKER.—A cement which would set reasonably slow, so that it can be manipulated properly, but which in twenty-four hours attains the strength which we generally now realize in a seven-day test.

MR. NEWBERRY.—It is perfectly possibly to do that, but it is not possible to make a cement which will not become quick-setting on storage, and in warm weather. There are chemical reasons connected with that which I would not care to go into this morning. I will only say, if they are high in silica and low in alumina, the result is better; and a much more satisfactory cement can be made out of high silicious material than out of high aluminous material.

With regard to strength at short periods, I understand Mr. Barker wants high strength at twenty-four hours. Any cement manufacturer can give you that by burning his cement comparatively light, and by grinding it exceedingly fine, particularly the latter. By grinding our cement to all pass a 200 mesh sieve, we could give you a cement that would get all of its strength in an hour or two. That is not what engineers want and that is the thing we have to try to avoid, getting too high strength in short periods. More engineers specify nowadays that we must have a percentage of increase between seven and twenty-eight days rather than a certain strength in twenty-four hours. That is becoming more and more recognized to be bad practice. I prefer great strength in twenty-four hours, and the manufacturer's effort now is to prevent a cement being too strong in short periods, rather than to get a high strength in short periods. Anybody who asks for high strength at short periods, merely demands that the manufacturer shall grind the cement exceedingly fine, and we will give it to him. Anybody that asks for

little strength at short periods, and high strength at long periods, will necessitate our grinding the cement comparatively coarse or adulterating it with some inert material. That would give the result. Those things, then, are comparatively within the control of the manufacturer. By regulating his fineness of grinding, he can get greater strength at short periods, or a better increase of strength at long periods.

TESTS OF BUILDING BLOCKS.

By R. D. Kneale.*

This paper is a description of the tests of some thirty plain concrete building blocks, which were about one year old. They were of the usual type, 16 x 8 x 6 inches, with two 4 x 5 inch inside openings. All were made of the same materials and treated as nearly alike in manufacture as possible. The materials used were Lehigh Portland cement and gravel 100 per cent fine on a sieve of one-half inch mesh. The proportions were 1 of cement to 5 of gravel. Each block was faced with 1:2 mortar, using the same cement as in the body of the block, and using an ungraded, clean river sand. The faces were so well bonded to the block that in no case did failure occur between facing and block. The faces were approximately one-half inch thick, and were not considered in figuring the cross sections used in compression tests. After initial curing the blocks were stored outdoors without covering. They were selected at random for the test from large piles exhibited for sale.

The blocks were tested in the laboratory for testing materials at Purdue University. The results of the tests are as follows:

Six blocks were broken in flexure. Two 1-inch wrought iron rollers were placed 14 inches apart on the platform of a Riehle 200,000 pound vertical testing machine. On these rollers the block was placed, with the facing vertical. A third roller, 1 inch in diameter, was placed parallel to the others on the center line of the block, and the compression head brought down on this roller. The results given below show fair uniformity:

FLEXURE.

No.	Span.	Load at Failure.	Modules of Rupture (lbs. per sq. in.).
1	14 inches	6,040 lbs.	300
2	14 inches	5,270 lbs.	260
3	14 inches	4,900 lbs.	242
5	14 inches	3,900 lbs.	192
5	14 inches	4,300 lbs.	212
6	14 inches	4,800 lbs.	240
		Average, 4,485 lbs.	241

*Instructor in Civil Engineering, Purdue University, Lafayette, Ind.

Twenty-four blocks were tested in compression—six in columns one block high, two columns two blocks high, two columns three blocks high and two columns four blocks high. To give an even bearing on the machine, the columns were bedded in plaster, and to give an even bearing on each other in the column one series of blocks was cemented into columns with plaster, the other series with neat Portland cement. This difference of bedding material, however, gave no appreciable variation in results. All columns failed in similar vertical planes through the partition walls. The results of the compression test are as follows, the 200,000-pound Riehle vertical testing machine being used:

No. of test.	No. columns tested	No. of blocks in column	Loads in 1,000 Pounds											
			First Crack.						Maximum.					
			Total.			Lbs. per Sq. In.			Total			Lbs. per Sq. In.		
			Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Min.	Max.	Avg.
1	5	1	195	106	146	2.19	1.15	1.63	195	107	152	2.19	1.17	1.68
3	2	3	145	106	126	1.63	1.22	1.43	145	115	130	1.63	1.32	1.47
3	2	3	145	100	123	1.63	1.15	1.69	163	115	139	1.63	1.20	1.41
4	2	4	146	119	133	1.63	1.36	1.49	146	119	132	1.63	1.36	1.49

Weight.

The average weight per block was 55 pounds. The average weight per cubic foot of material was 147 pounds.

Absorption.

Half blocks, after drying two days in the heating oven, were immersed in the water and absorbed 6½ per cent by weight after four hours' immersion. After four days immersion this per cent of absorption increased only ½ per cent. On immersing the face only, it absorbed 2.3 per cent of the weight immersed in four hours.

Summary.

The results of the test then show that the modulus of rupture is 241 pounds per square inch, which is 85 per cent of that de-

termined by Fuller for 1:3:5 concrete beams. The strength per square inch in compression averages 1,500 pounds, or about 60 per cent of the strength of solid cubes and cylinders of 1:3:5 concrete as given by various authors. This compressive strength shows little variation for columns up to four blocks high.

Results throughout the test checked with fair uniformity.

REPORT OF COMMITTEE ON MACHINERY FOR CEMENT USERS.

By J. F. Angell, *Chairman.*

In taking up the subject of Machinery for Cement Users, one realizes that what has been and what can be or should be said regarding same would make a good sized book. However, I do not feel that I can add much to what has been brought out on the subject at previous meetings of this kind, neither do I think it would be justice to those assembled here for me to endeavor to make them believe I know all that is to be known about cement machinery, for, in my estimation, there is still so much to be learned it will keep all that are interested very busy for some time.

Some say the experimental point has been passed. It is perhaps true that the matter of the durability of cement products as a building material is no longer an experiment or a conjecture, but how many manufacturers of cement machinery or cement blocks know or have made an effort to ascertain what is necessary to furnish material that will meet the requirements of the architect or builder I believe you will agree with me there is a very limited number.

I think I am safe in saying that the majority of those who have embarked in the cement block business never thought for a moment what would be required of them in the way of furnishing blocks of different sizes, designs, etc., but as a rule it was not long before they realized that their patrons demanded something more than a foundation block, making it necessary to purchase additional parts or better machinery, and with this experience no doubt they would advise those anticipating going into the business to investigate carefully and to purchase the proper kind of machinery and enough of it to meet the demand.

Generally when an individual or a corporation decides to manufacture cement block the first thing they do is to write to every cement machinery manufacturer they have ever heard of,

or can find advertised in the trades papers, for catalogue and other printed matter. In due time they receive a great number and variety of booklets, setting forth the merits of the various machines, each claimed by its maker as the best and only one on the market that will meet all requirements. In addition to this the would-be purchaser's life is made miserable by agents or the representatives of the different machine companies, and after they get through telling him or them all the superior points of their machine and the inferior points of all others the prospective purchaser finds himself entirely at "sea" and hasn't the least idea what he wants, consequently he is obliged to adopt some other method, and in thinking the matter over he naturally looks the catalogues, letters, etc., over again and selects a few of the machines that strike his fancy and writes the manufacturers for further information and prices. The prices he receives of course vary and the question of price should always be considered, but it should not be considered at the expense of a good product.

A machine should be judged according to its value as a producer. If it is well and honestly made and capable of producing a large variety in the way of sizes, designs and perfect block, it is better and cheaper than a machine that costs less and is capable of producing only one or two size block, and the purchaser will realize this as soon as he fairly gets into the business. It is sometimes hard to make him understand this before he has had the experience, and, as a rule, he is slow to be convinced that the best money he can spend is for a good concrete mixer, to properly mix his material. At the same time it is no trouble to convince him that it is necessary to purchase the best grade of cement, but he will insist that on account of his going into the business in a small way mixing this "high priced cement" by hand will answer, for the present at least, not realizing that it is impossible to mix the material that way so the amount of cement and sand, or other material, will be the same in each block, therefore making it possible for the block to be criticized and probably condemned, especially in new territory.

No one knows better than the machine manufacturers how difficult it is to convince a purchaser what is for his best interest, and I feel that in a great many cases the manufacturers or their

representatives are to blame. Why? In the first place, I believe we will all agree that no business for years has made the progress or has been brought to the attention of the general public as rapidly as the product of cement as a building material. It has been so rapid and attractive and the prospects of large and quick returns have been so flattering that hundreds of inventive minds have been put to work, for the purpose of bringing out a cement block machine a little different from some other, and so well has the inventive genius of our great country been brought to the surface the market is flooded with cement block machines that can be bought at any price, from $5 up to $800 or $900, and in a great many instances the agent is allowed to regulate the price to the detriment of the manufacturer. And in looking over the vast number of machines it is no hard matter to see that only a limited number of the inventors or manufacturers had anything in mind but the bringing out a machine for the market, thinking it a gold mine and entirely losing sight of the necessity of producing a machine that will produce material to satisfy the architect and others. We often hear people say, "Why are the architects so slow in recommending cement block?" Can we wonder at it when we stop to consider that perhaps not one in fifty inventors or manufacturers even thought it necessary to confer with an architect or builder to ascertain what they want a machine to produce, and at the same time we know that no one is more particular and harder to please than an architect, and he has a perfect right to be, as his business and reputation depends entirely on the work he produces, and we cannot expect any responsible architect to throw aside different material he has become perfectly familiar with for one he knows little about, until such material is given to him in perfect condition and in all the sizes and forms he desires. When this is done, I anticipate no trouble in the way of architects being with us.

A number of manufacturers have put in years of study and energy and any amount of money in perfecting their machines, and have succeeded in bringing them to the point of perfection, and have been rewarded for their efforts to give to the public machines noted for their simplicity in construction and free from complicated mechanism as possible, and while continually reach-

ing out for better means of operation they never for an instant have lost sight of this point so important to the operator. At the same time it is unfortunate that many a good machine has been condemned owing to the use of poor material and the unbusiness like method of the operator. For instance, I heard of a case only a short time ago, where an operator had a fairly good machine, but the machine and the blocks he produced were condemned on account of the blocks disintegrating in the center, and upon investigation it was found he made no effort whatever to tamp the material, simply filled the mold box and struck it two or three times with a piece of plank to which a handle was attached, and when he was told he should tamp the material properly, he replied that his way was good enough, as it forced all the air out of the block, and no doubt we would find many cases just as ridiculous as this.

We feel, however, that there has been a vast improvement in the past year, both in the manufacture of cement block and machinery. We realize it more every day, as we find those who contemplate purchasing machinery are taking more time in getting information relative to the business and investigating the merits of different machines and making an effort to purchase enough and the right kind of machinery before establishing their plant.

My idea of establishing a cement block plant is to use the same discretion and judgment as is generally used in establishing any other plant. No person or company ever thinks of establishing a brick plant with anything but the best and a full line of machinery, regardless of the cost, and when we consider the cost of brick machinery as compared to cement block machinery we wonder why there should be any doubt of the advisability of using the same method in purchasing cement machinery, and I would suggest to those contemplating going into the business and to those now in the business and wishing to enlarge, spend a little time and money in investigating, call on the manufacturer, see what he has and give him an opportunity to give you the benefit of his experience, and if he is honest and has the cement interest at heart you will be the gainer. Do not hesitate to purchase good machinery, cars, ornamental molds, etc., and if you are so situated as to make it possible, establish a steam curing

plant. Then make good honest block, get the confidence of the public and there will be no doubt but what cement block will be appreciated and you will find it a profitable business, for such has been the experience of those who have endeavored to do business in this way.

I might dwell further on this subject, but feel it would only be imposing upon your good nature, and I would probably only repeat what you know and have heard before, besides I feel that the time of this convention is entirely too valuable to be taken up further by me, and in conclusion I hope I may be able to impress upon every member of the association the importance of putting forth their best efforts in furthering the cement interests and by practicing what we hear, so that The National Association of Cement Users may continue to be a success.

TOPICAL DISCUSSION ON THE MANUFACTURE OF CEMENT BLOCKS.

MR. M. S. DANIELS.—One of the difficulties we have found as block manufacturers is in persuading the architect to plan a building in accordance with the unit of measure which exists in the blocks we manufacture. If we could in a measure induce the architect to draw his plan first, taking his unit of measure from a block, as he would do if he were constructing a brick building, I think one of our difficulties would be out of the way.

Another thing, we allow our buildings and our stone to be condemned for faulty erection. A few weeks ago it was my privilege to be in New Orleans, and I there examined a large residence building which had been constructed at considerable cost. To my amazement I found that the sill of the most prominent window in a bay had been stock size, and projected on both sides of the opening at least fourteen inches beyond what it should have. No effort had been made to fit the sill to the space it should have occupied. The blocks had been broken and placed with mortar joints from two to three inches wide, in order to fit the plan of the building.

It would seem to me that we might avoid some of our difficulties perhaps, if we would see that the stone was put up in the manner in which it should be.

The last building in which I was interested I stayed on the work myself for a portion of the time and insisted that the blocks be laid up with thin mortar and a very tight joint, just as close as it could be made. It is the best job we could have, and no moisture comes through it. Before I came away I examined it. Notwithstanding the fact that there had been a great deal of rain and moisture since the building was erected, I could not discover that there was any moisture coming through those walls. Now would we not do well to see that the people that put up the stone that we produce put it up as I think it should be, and as probably you think it should be, with a very close joint; and then have it pointed up as we may think desirable? I think we shall then have a building which will be attractive to any one who

wants to have a residence or any kind of a structure put up for which he has to pay.

Now, I have found that some blocks in buildings in which I am not particularly interested have cracked, and there have been various reasons given for the cracking of blocks in those buildings; some of the reasons will be brought out before we adjourn.

It seems to me that the best way for the manufacturer to protect himself would be to have a voice in saying how his material is to be used. A plan should be furnished so the block can be manufactured to fit a given space without cutting. The manner in which the blocks are to be laid, the proper joint to be used should be specified, in order to protect the manufacturer and his products. There is one concern which is doing a satisfactory business on this basis, and which, furthermore, makes the condition that the stone itself shall be put up in a workmanlike manner and under the supervision of that concern or its representatives. Under no other conditions whatever will it permit the stone to be made and delivered. I am of the opinion that that is a good business proposition, and I am confident that any building put up under such conditions will surely draw more business to the firm if there is other building done in the vicinity.

MR. C. WALKER.—I have had trouble with stones cracking in the wall, and on investigation I have found generally that it is due to careless mortar makers. If slaked lime is used, it may be due to lumps in the lime or it may be due to large particles in the sand. The lime should be run through a screen to take out all stones, and the sand should be screened just as fine as you want to lay the joint. If you want to lay a quarter of an inch joint, you should not have a screen coarser than a quarter of an inch. I find every time a stone cracks vertically there is a pebble or a stone underneath.

MR. M. S. DANIELS.—Have you had any experience with not only one block cracking, but all the blocks immediately above it, either through the joint, where it does not crack the block, and through the block next above, and so on?

MR. C. WALKER.—I, personally, have not, but I have seen others, and by investigation I find that the foundation is not strong enough for the building.

A MEMBER.—In one building that I erected I laid the block myself on purpose to test the laying of the block, and to learn how to lay it properly, so that it would not break. I have been selling my blocks and making every effort I could to get them laid properly, but I find I cannot do it. The masons are too careless in making their mortar. They do not screen the gravel out of their sand, and therefore by having gravel at some point in the cement it causes cracks. They are also careless in laying the mortar on the blocks. You can break the block very easily by laying it full in the center and not on the ends, or *vice versa.* If that block is not laid right away before the mortar gets a chance to set it will almost certainly break the block. Of the blocks that I laid myself I have had none broken. I screened all my sand and all my lime through a quarter-inch sieve. I started my foundation on a concrete footing in the cellar and have had no trouble. Although subjected to very severe rains, the blocks and joints seem to be impervious.

MR. M. S. DANIELS.—What are the dimensions of your stone?

A MEMBER.—The stone was 8 x 8 x 20. I also laid 8 x 10 x 24 for the foundation.

Some of the blocks had been made sixty days, and some not over thirty days. Others had only been made about two weeks. There were some special blocks that I had to have, which were put into the building as soon as hard enough to haul to the site.

The plastering has not been done yet, as the building is not completed. The block is a 1 : 5 concrete with all particles larger than 1 inch screened out, with a 1 : 2 face and a waterproofing of alum and lye. I have had no trouble with dampness with the severe rains that I have had.

MR. E. S. LARNED.—What is the composition of the mortar in which the blocks are laid?

A MEMBER.—I used a sand and lime mortar. The lime is lump lime, which is allowed to slake and cool to a paste, after which it is thinned with water.

MR. C. E. MARKS.—I have had a great deal of trouble with water seeping through the joints in a wall in which blocks 24 x 8 inches were used. The blocks were practically non-porous, but

about very eight inches down the wall there was a damp spot. We have tried to overcome that by stopping our mortar joints; that is, we put the mortar joint on the face and on the back. I have tried waterproofing, but the water still comes through.

MR. MASON.—If the joints are pointed up with a good cement mortar I think no water will go through them. I have found that very efficient.

MR. PHIL SCHALLER.—We have had the same experience. We put up a building and it leaked everywhere through the joints, and through the stone. The stone cracked, and we knew we were doing poor work. But we turned over a new leaf. We made a better stone, using 1 : 3 mortar and taking more care in molding. We hung our tampers from spiral springs and found that with this arrangement we could tamp a much harder block. Our buildings are now very successful.

MR. ALBERT OLIVER.—I think Mr. Marks made a mistake in laying up his wall with three parts of sand and one part of cement. I think it is an utter impossibility for anybody to lay up tight joints whether in blocks or in stone or brick, because there is not pressure enough.

A tight joint can, however, be obtained by using a plastic mortar, one containing lime. As the house now stands I do not know how to close the joints.

MR. G. B. ASHCROFT.—I think I can answer that, as I have had a good deal of experience in making mortar. I use the ordinary lake sand, running it through a dryer, such as we use for drying sand for mortar making. The sand is thoroughly screened and thoroughly dried. I then add to that one part of cement and one part of lime and three parts of sand, mix this up thoroughly in dry form and send it to the work that way. We have never had any trouble with mosture getting through the joints.

MR. H. B. ANDREWS.—We have just completed a large building and used the mortar exactly as described by the last speaker. There are no leaky joints in the building.

PRESIDENT HUMPHREY.—I have in my hand slips of paper bearing questions which cover subjects from A to Z. I don't know what would be the best way of taking these up. Some of

the questions are difficult to answer; but I will take them as they come along. They have been grouped together, so we shall have all questions in one group.

The first question I have in hand is one which has not been discussed, and relates to the size of the block. The question asked is:

"What is the most economical size for a block?"

Now the blocks that we use are more or less the size for which the machine manufacturers build the machines. It would seem that there should be some standard machine to set some standard size for a block. At the last convention of the block machine manufacturers the question came up in connection with the tests which were going on at St. Louis as to what size blocks should be tested that should be representative. We found that the different block makers had different sized blocks. After wrestling with all the different types of machines that were represented at that convention, it was finally agreed that the length of the block should be twice the width; in other words, in a ten-inch wall the block should be twenty inches long; if a twelve-inch wall, the block should be twenty-four inches long. I think it might be well to discuss that briefly.

MR. J. G. HAMILL.—I take it that size 8 inches by 24 inches, divided into quarters both in height and in width, makes a multiple of two inches for the height, two, four, six, eight, and six, twelve, eighteen and twenty-four for the length horizontally, which makes an easy multiple on which to figure and work out stock heights for window frames and doors. As a practical builder, I find that these dimensions work out well for openings, and come pretty near to brick. I think a good practical size is eight inches by twenty-four inches brick measure, regardless of the thickness of the wall.

PRESIDENT HUMPHREY.—One of the points raised is that you are too prone to make a block of a definite size, and one of the complaints that the architect has is that he is forced to take blocks of a certain size. Now there should be no size. The blocks should be made to suit the design, excepting where you are to furnish stock sizes. But there are certain conditions under which you must have a block that is going to suit the design, and

the building ordinance is going to decide how thick the wall must be to carry the load.

MR. H. B. ANDREWS.—I believe the size should be the most convenient and economical for one man to handle in the wall. I believe in a block 8 inches by 16 inches, weighing about 75 pounds.

PRESIDENT HUMPHREY.—But, on the other hand, there is no reason why concrete blocks shall not be made of any size, if you can use such blocks and lift them in place with a small hoist of some kind. The use of blocks is not necessarily going to be confined in the future to small buildings, but is going to grow, and blocks of larger size are sure to be used. This will be particularly true of factory buildings.

MR. M. S. DANIELS.—I am of the opinion that it is a good plan to make a block somewhat according to the size of the building you are going to put up. Now I think a factory building where the walls may be thirty to forty feet high, built with a twenty-inch block, does not look nearly as well as if you use a thirty-inch block.

MR. W. N. SORTER.—I think when you speak about making blocks of different size we are losing ground. We find in the east that the only practical way to do is not to argue with the architect about the size of the blocks, but to take the plan and say: "We will guarantee a fit," and we find that very satisfactory.

MR. F. WYATT.—When Mr. Humphrey spoke of having the block maker make blocks to suit the architect, I was wondering why it could not be done in the case of brick buildings. The brick makers all make their brick standard sizes, and the architect has to conform to them. I have been trying to educate an architect in my town to conform somewhat to the sizes of the blocks, and he is, I think, turning out pretty good results. If the architects would take that in consideration instead of making a design regardless of available sizes, they would get along a great deal better than they do.

A MEMBER.—I have had occasion to build several houses of concrete blocks, and when I had my plans prepared by the architect, the first question he asked was, "What is the size of your block?" After telling him what I could make with my machine, he conformed his plans to that, and I had no trouble.

PRESIDENT HUMPHREY.—There is another question which is more or less closely related to the preceding, and that is the average cost per square foot for placing blocks in the building up to 22 feet above the surface.

MR. ANDREWS.—We have found that it has cost us to lay 8 inch by 16 inch blocks anywhere from fifteen to twenty cents a square foot, with mason labor at 45 cents an hour, figuring in the cost of the mortar. It costs very little more in proportion to lay a 10 inch by 12 inch block.

MR. LARNED.—What is the cost of the block?

MR. ANDREWS.—The cost of the blocks will vary a great deal, according to the expense of the materials, and where you manufacture the block, whether it is on the site of the building or whether it is manufactured elsewhere and carted to the building. But on two or three jobs we have found the cost of the block from eighteen to twenty cents per cubic foot of block, and the cost of laying it would bring it up to thirty-eight cents or forty cents per cubic foot in the wall.

I might say that in the building we put up we followed the architect's plans who designed them, and we made some one hundred and fifty styles of blocks in one building, and two hundred and twenty-five in the other. This may account for the high values that we found for the costs.

MR. HOTCHKISS.—The price in Chicago is five cents up to the half story above the ground, and seven cents to the second story. We are not allowed to build concrete buildings over two stories here.

MR. WILLIAM CONK.—Being a practical bricklayer for years. I am in favor of stone not larger than sixteen inches, for two reasons: In the first place, a stone over sixteen inches is heavy; the mason does not want to handle it. If he does lay it, and after spreading his mortar finds it a little high in the center, he is not going to take it up, for it is too heavy, but if it is a sixteen-inch stone, one man can raise it, and do it easily. The chances are that if he finds it is a little down in the center he can take a small stone and pack it down until it beds properly, and there will be no chance for a break. So I am favorable to nothing larger than a sixteen-inch stone.

A MEMBER.—We have under construction a 40 ft. by 70 ft. store building. It is a two-story building with an 8 ft. basement. The basement is built of 12 inch by 24 inch blocks. The next two stories are put up of blocks that are 9 inches by 18 inches. The cost of the 18 inch block is eighteen cents. We let the contract for laying this at seven cents per foot, the mason to furnish the mortar. That makes a cost of twenty-five cents per square foot of wall.

MR. MERRILL WATSON.—There is a thought which I desire to present to the block maker, and that is: that I believe the block manufacturer is on the wrong track. It is perhaps pure cheek for a man to make such a statement, who confesses he never made or owned a cement block in his life.

Let me say at the beginning, I am not criticising the block you are making—you make it well and make it cheap; but this is the point: My architectural friend has just stated that no machine block will ever please him, for, to his mind, there is no possibility for individuality in a wall constructed of them. It is a block and another block in monotonous succession, all exactly alike.

Now, I sell a building material. I sold six million feet of it last year scattered around in various structures, but you could not find an inch of it. I lost sight of my material and have nothing to show. You show your buildings and photographs and have something to look at. Now change your position and sell something for people to hide. Forget it as the outside of a building and think of it as the structural wall of a building, as a curtain wall, if you will and stop there. Our architectural friend can plaster on such a wall and can, therefore, use your material.

You will sell just as many blocks as you did previously, and yet not have the trouble about rock faces, and all that sort of thing; you simply supply a material to be hidden, a wall to be finished by plastering or other ornamentation.

This will open up a new field, and I hope by next year we will have a little information on what you have done in trying to make beautiful houses and still make blocks.

MR. E. S. LARNED.—I thought I knew Mr. Watson pretty well, but I am inclined to ask him where he has been during the last two or three years.

If there is any one style of architecture that meets with universal approval, I have yet to see it. It is certainly variety that the architects want, and that we want to give them. The curtain wall idea is not a new one. Block makers have been making curtain walls since they began to make blocks, and it is not the monotony of successive rows of blocks of given dimensions that the architect complains of. It is the character and appearance of the surface of the blocks. I take it that Mr. Watson saw the slides shown and described last evening.

There certainly was a great deal in that display of real artistic merit, and it points out the possibility of block or concrete construction.

Now, if one architect wants curtain walls, and wants to bury the blocks behind reinforced concrete, we will try and give them to him, but let us also try to educate block makers to make artistic blocks. It is perfectly feasible; it simply means a little care in the selection of aggregates, and in the treatment of them.

PRESIDENT HUMPHREY.—At last night's session Mr. Comoli touched very briefly on a method of finishing old concrete, stone or brick surfaces, and we would now be pleased to hear from him in more detail.

MR. P. P. COMOLI.—The method I am about to describe can, with the aid of a little skill and judgment, be applied to finishing either wood, brick, stone or concrete surfaces.

Before anything is done to the walls of a building they must be thoroughly cleaned. All mud or loose material must be first removed with a steel brush and the surfaces thoroughly dampened until it refuses to take up any more water.

All surfaces that are to be left smooth are finished first, since any mortar that spatters over on the smooth surface when the rough cast is being put on can easily be brushed off. The mortar for the smooth finish is mixed very wet and thrown against the wall with a brick trowel in such a way that it will penetrate the pores. After that it is not touched until it begins to set, unless it begins to dry out, when more water is applied.

This first coat forms the bond for any other mortar which is put on and must be thrown against the wall with force, not trowelled on. The remaining coats can, however, be put on with a trowel and worked to a smooth finish without fear of breaking the bond to the wall. This method is much more successful in a temperature just above freezing, since the slower hardening of the concrete gives a much better bond.

The preparation of a wall for a rough cast finish is similar to that necessary for a smooth finish. The method of placing the mortar is, however, somewhat different. The mortar is mixed to the same wet consistency as that used for the first coat of the smooth finish, but instead of being thrown against the wall with a trowel, which produces a more or less blotchy, uneven surface, it is applied by dipping an ordinary broom in the wet mortar, stepping back a pace or two from the wall and striking a piece of wood in such a manner as to cause the mortar to be sprayed against the wall. Care must be exercised in applying the last coat of the rough cast to see that the mortar in the previous coat has reached the same degree of setting or suction over the wall area to be finished on that day, as this precaution is necessary to insure a uniform shade in the last coat.

Any color that it is desired to give to the wall is mixed in the dry state with the cement.

The methods I have described require more or less skill on the part of the workman in judging the condition of the surface to be finished, and an imperative condition is that the mortar for the first or bond coat must be thrown against the wall with force.

PRESIDENT HUMPHREY.—A number of questions have been asked which I will now try to answer. The first is, "What is the effect of damp sand on cement?"

If you mix damp sand with cement the water present will begin to act on the cement and the setting will begin to take place, and if you let the mixture stand for any considerable length of time the whole mass will get hard. It is evident, therefore, that if you want to mix up the materials and have them stand, the sand ought to be dry. If it is wet you must use it as quickly as you can, because every moment you let it stand the cement is setting, and if you regage it you weaken it to that extent.

The second question asks: "Which is the most durable block, the slush block or a damp or dry process block?" I presume by the term "durable" is meant which is the strongest block? From the results of tests that I have made, it seems that the wet block gives a greater strength in at least the earlier periods than the block made by the dry process.

MR. DANIELS.—Do you think that this would be true of tests made at the end of three years?

PRESIDENT HUMPHREY.—That, of course, is problematical. Dry blocks, if kept sprinkled and given a chance to harden, acquire strength. Density and strength go hand in hand, and the trouble with a dry, damp block is that it contains a large percentage of air that cannot be worked out, because of the stiffness of the mixture. This is evident when a dry tamped block is tested for absorption. Now the mere fact that the block does have an absorption for water is an indication that the block contains pores; that is, void spaces; and a block of that character has less strength on short time tests, and I doubt whether in a long time it can ever have the strength of a denser block.

The next question asked is, "What merit does furnace slag have as a concrete material?" That is rather an ambiguous question, as there are so many different types of furnace slag. The old kind of blast furnace slag, which was made in the old pot kettles, is a hard, dense slag, and is supplied in some parts of the country for use in concrete. It has usually been exposed to the weather in piles for a long time, and any large quantities of sulphides in the original slag will have had a chance to oxidize in the air, thus removing this objectionable feature. If the slag was still hard it would make good concrete. On the other hand, there are some slags which contain large quantities of sulphides, and the oxidization of these sulphides is accompanied by a disintegration or breaking down of the slag. Under the new process you get the granulated slag, and slag sand of that character is used largely and gives a concrete of excellent strength.

I should say that slag has no special superiority in a block over any other good material.

MR. J. R. GILL.—I am located where slag is the only material you can depend upon getting. It is used very largely in con-

crete work, but we were advised not to use slag in blocks, because of the thinness of the blocks, the claim being that in even concrete construction the slag is so encased that conditions are different. In a thin block there might be, in the course of years, some chemical action which might destroy the strength of the cement. That slag is used very extensively within freight distance from Birmingham, Ala. In Mississippi it is the only material you can depend on except broken brick.

PRESIDENT HUMPHREY.—There are two kinds of slag; one know as acid slag, the other as basic slag. The acid slag is a high silicious slag; that is, a slag that contains a great quantity of silica, and is very hard and dense. A slag which contains an excess percentage of lime is called a basic slag, and one that contains a larger per cent of silica, what you know as sand, is called an acid slag. Now a slag that is high in lime, when exposed to the air, will slack just like ordinary lime and go to pieces, and can, of course, not be used in concrete. The silicious slag, or the hard slag, is one whose only objectionable quality is the amount of sulphide which may oxidize. I do not know if it will affect the quality of the cement at all, but the process of oxidization of this sulphide produces swelling, which disrupts the mass in which that concrete is used. There are a great many furnaces in Birmingham, and some of them make a silicious slag which seems to be of good quality. It is always safe to use slag from a pile that has been exposed to the air for a long time, because then you have a chance to see whether there are any elements present that may cause disintegration.

MR. H. WIEDERHOLD.—This is a question on which I would like to say a few words, as we have had a sad experience with slag. Formerly we obtained a slag from which all the iron had not been removed and which had been exposed to the weather in piles for a long time. With this slag we obtained excellent results. In the course of time the slag from these banks was used up and another slag which had not weathered so long and from which, by a different process, more iron had been extracted, furnished by the contractor without notifying us. During hot summer weather, and particularly after a thunder storm, the pavements would rise and disintegrate with a loud report. From

this experience I would never recommend the use of slag without previous weathering.

PRESIDENT HUMPHREY.—The character of slag varies very materially. Some slag is very porous and spongy, but is, nevertheless, hard. When this is mixed with sufficient mortar to fill the pores, it makes a very dense concrete, but more mortar is needed to fill these pores than would be the case if a slag were used in which the material itself is dense. The slag that is best to use is a very dense, hard slag. Very little of such material is found in the slag piles of to-day, and in addition there is usually a great deal of sulphide present which will expand and disintegrate the concrete.

This is the next question: "Is there any good reason for objecting to fineness in facing material other than the sand?" I don't know that there would be any objection to the fineness if the material had a proper percentage of voids. The object in putting on that facing is to give a dense, hard surface, and it is necessary to use a sand which will give you a dense, hard mortar. You must find out something about the voids in the sand that you are using and fix your proportions accordingly.

MR. LARNED.—A good deal has been said about the consistency of mortar and the effect of water on mortar, all of which, I think, has been understood and appreciated and given due weight. Now, in making a fine facing for cement blocks, it is usually customary to make the blocks face down, and the practical cement makers have found that it is to their advantage to use a rather drier facing than the material they put in the body of the block, because by so doing they think they get a clean impression, and have no difficulty with the material sticking to the plate. Now, inasmuch as this is pure theory, I would like to throw out the suggestion that perhaps by reason of the fact that that facing is dry material it is not so uniformly supplied with the necessary water for crystallization as if it were of the same consistency as the backing material, and further than that the co-efficient of expansion and contraction between mortars of different compositions must also be taken into account. A fine material of a rich composition will have a different expansion and contraction than a coarser material of a leather composition,

and, if so, there may be a parting between the facing and the backing. Those are two considerations that I think enter into the proposition. I was in hopes of hearing from somebody who had had this experience.

PRESIDENT HUMPHREY. This is the next question: "Is the submerging of blocks considered a superior method of curing, and does submersion do away with all sprinkling?"

The ideal way of curing blocks is to keep them surrounded by moist air from which they can absorb water, for nothing will draw moisture from a block so completely as dry air. That, of course, may not always be practical, and the amount of spraying the block ought to receive will depend on atmospheric conditions. At a time when the air is very dry or if the blocks happen to be in a current of dry air, a man might have to be kept there constantly spraying water on the blocks to prevent them drying out. If the blocks are stored in a closed room it may be possible to leave the spraying go for a longer time. If, after they have set sufficiently hard, it were possible to submerge the blocks, they would require no more attention.

There may be objections to submerging the blocks. There may be something in the water that would discolor or stain the block, so on the whole I think probably one of the best method would be to keep a uniform spray going over the block.

The next question is: "If limestone is used in concrete blocks, is it a good material to resist fire?" Limestone, of course, is disintegrated at comparatively low temperatures by fire. If a building constructed of blocks in which limestone is the aggregate, is subjected to fire, the heat will drive off the carbonic acid gas and reduce the limestone to lime, and the first water that strikes the block from a house will cause that lime to slake and the surface of the block will go to pieces. The depth of the calcination will depend upon the duration of the heat, it being only a question of time when the block is destroyed. Of course, if you keep the stone back from the surface of the wall and have a face mortar of sand and cement, which acts as a protective covering, you may keep the stone from being disintegrated; but if the heat is intense it will go through the mortar and the limestone will be disintegrated.

Another question is: "What is the cause of efflorescence and what are the means of overcoming it?" I believe that the more porous a material is the greater is the efflorescence likely to be. If the block will take in water from the surface, then a house laid up with a block of high absorbent qualities will permit the entrance of water. Perhaps a driving rain storm beats against the side of the house, and the water penetrates into the heart of the block. Some of the material in that block is soluble in water, and after the rain storm the sun may come out or a dry wind may blow, and the block is surface dried. The water in the block comes gradually to the surface, and with it are brought the salts that have been dissolved, and you will have efflorescence. You may go over that block and clean it with acid, and then perhaps a harder rainstorm will come and drive the moisture in perhaps a greater depth, and you will have efflorescence again. You find that in brick that has absorbent qualities, for it is due only to the salts that are brought out by the water. One means of overcoming that will be, of course, to make the block dense, and the denser it is perhaps the less will be the absorption.

There is one question I will ask Mr. Stanley to answer. It is: "What causes pitting in cement sidewalks?"

MR. GEORGE L. STANLEY.—Pitting may be due to many causes. Perhaps one of the principal causes that we have is the cement becoming moist and partially set before it is used, so that it will not have its full strength. This will show as gravel-like lumps when the cement is mixed with sand, instead of giving a smooth mix, as would be the case with new cement. This may be largely prevented by passing the cement through a No. 6 or 8 sieve, thus removing these lumps of partially set cement.

Another cause, perhaps, would be due to what we call sanding, which is caused by water collecting on the pavement. When the pavement is opened to use, the thin scale brought up by trowelling will wear off, and that will wear it pitty. Those two causes are the only ones of which I know. Pitting may, however, also occur when too little cement is used.

JOINT MEETING ON THE SECTION ON TESTING CEMENTS AND CEMENT PRODUCTS, AND THE SECTION ON CONCRETE BLOCKS AND CEMENT PRODUCTS.

A MEMBER.—The question of the advisability of using cinders has been discussed before, but nevertheless I would like to reopen that subject. For a backing to my blocks I am using a concrete in which the aggregate is a mixture of a coarse bank gravel and a cinder obtained from burning pea coal. The cinder is very angular, can be readily broken by the blow of a shovel, and runs from ½ to ¾ inches down to dust. I find that this mixture tamps much better and closer and yet gives a block about three pounds lighter than one in which the aggregate is only gravel. The blocks are all faced with a 1 : 2 sand mortar.

PRESIDENT HUMPHREY.—A great deal of the cinders comes from burning bituminous coal, which very often has sulphur present as sulphide. This may oxidize in the cinders, and when brought in contact with water a free acid is formed, which will help disintegrate the blocks. The strength of a cinder concrete block is much less, say roughly, 50 per cent of that of good stone concrete. In many cases it has a very much lower strength, so that while you are adding cinders to lighten the block, you are also decreasing the strength. There is, however, some hard, dense clinker which does not materially lighten the block although it makes the concrete of less weight per cubic foot than ordinary stone or gravel concrete.

If you think that by using cinders the strength of the block will be increased, I should say you might be taking chances, although anthracite coal does not contain the same amount of sulphur and there is, consequently, less danger than if you would use cinders from bituminous coal. Of course, it is a practice all over the country to use cinders in concrete, especially in floors where it is desirable to lighten the weight. In San Francisco, for example, I suppose 90 per cent of the floors were built of cinder concrete.

I was requested during the early part of the session to make some statements on the subject of cement. The request came in the form of a question as to whether or not any special rock or material made a better cement than others. Many people seem to think that perhaps the material that is found in one locality will make a superior cement, and perhaps a few remarks on that subject may be acceptable to the convention at this time. I suppose there is no building material that is more sensitive to climatic conditions than cement. We heard the other morning that cement which, for instance, left the factory in perfectly good condition, perfectly sound in every way, might during the summer suddenly become quick setting and unsafe to use. You must bear in mind that cement is simply a chemical compound and is not stable or permanent until it has absorbed or has combined with it the amount of water necessary for the formation of crystals or compounds of silica, iron, alumina and lime, which constitute the hardening element of cement.

In the early days the Romans, you know, made cement by mixing hydrated lime with volcanic ashes, the lime combining with certain elements in the ashes to form a concrete which has lasted until our day. In the structures which we find existing to-day the mortar seems to be extremely hard and of superior quality, and we attribute it to the material, and yet it is probable that it was no better, perhaps not as good, as some of the ordinary lime mortars that we have to-day.

Lime mortar, if it can survive the early years of hardening, and the action of rains and frost, does become hard, because we have in this country samples of old colonial houses in which the mortar is extremely hard. The early experimenters tried to discover the supposed lost art of making this cement. When they came to build under water the English found that ordinary lime mortar would not do, for water dissolved it, and the structure would not stand. Experiments were made to find whether the lime made from one stone was better than another, and they found that the stone that had some ingredients of clay, which is a silicate of iron and alumina, had the qualities that made it harden under water and gave it strength. The reason for that is this: Ordinary lime will make a uniform solution with water

in all quantities, the mixture simply becoming more dilute as more water is added, until finally the lime is no longer visible and we have an opaque solution. That is the process that goes on when lime is under water, but when you take cement in which the silica or clay compound combines with the lime only in the presence of water, that action is completed shortly after the water is added, and the hardening will go on even if it is immersed. The material is hydraulic; that is, it will harden and set under water, and will not be further affected unless the water is charged with some material like an acid or some salt which will break down the compound formed and thus render the structure weak.

So much for the early history. They did find in time certain proportions which make a hydraulic cement, afterwards patented under the name of Portland cement.

There are lower grades of cement, such as natural cement which are merely hydraulic limes, and those, of course, have uses under certain conditions, but we do not pretend to use them where great strength or where great durability is required. They are slow hardening, have a low strength and are unsuited for most of our structures to-day where we demand high strength and especially high initial strength.

The manufacturer of cement must use certain ingredients. He must have clay and lime, the two compounds which enter into cement. The clay contains what is known as the acid element, and the lime what is known as the basic element, and it is a law of chemistry that a base in combination with an acid will form a compound or salt, and Portland cement is practically a salt.

The action of water on Portland cement is somewhat similar to its action on ordinary table salt. Salt and water will form a solution from which, if it is allowed to stand in a warm place, the salt will crystallize as the water evaporates. The action of water on Portland cement is very similar. The water dissolves the cement until a degree of saturation is reached at which the cement will crystallize. This process of crystallization will keep on indefinitely or until the space is so filled that no more crystals can form, after which a portion of the material remains inert or uncombined. The fact that some of the cement remains inert

in the hardened cement has been tested by grinding some of this hardened material up very fine and mixing it with water. Although it may take a long time, this mixture will eventually harden and acquire considerable strength, showing that not all the cement had been previously combined with water.

The chemist finds that approximately one part of clay and three parts of carbonate of lime are needed in the manufacture of Portland cement. The clay is either found free or as a shale, and the limestone may occur as limestone, marl, chalk, or again he may find approximately the correct proportion of clay and lime element in blast furnace slag, or in the so-called cement rock of the Lehigh District, which is a clayey limestone. But he must have a certain percentage of silica; he must have a certain percentage of alumina and a certain percentage of lime, although the governing percentages are those of silica and lime. From an analysis of his raw material, clay or shale and limestone, he apportions those two materials so as to give a resulting compound which will make Portland cement.

This mixture is ground to an impalpable powder, by which I mean a powder of which perhaps 95 per cent or more will pass through a sieve having 40,000 or more meshes per square inch. Material in the process of manufacture is introduced in that powdered form into a rotary kiln, a long steel cylinder lined with fire brick, slightly inclined and revolving on its axis. In the other end of the kiln, which is the end opposite that at which the material enters, there is directed a blast or flame usually consisting of pulverized bituminous coal. In some parts of the country, like California, they use oil, and in others, for instance, in Kansas, they use the natural gas, although they could use any gas that would give them a flame. The fuel is blown in with air, just as in a blast lamp, and is directed against the material as it comes down the kiln. The kiln revolves at a slight angle and the material gradually travels from the upper end to the lower end, where it is discharged. At the material is heated, the moisture that may be present is driven off, then the carbonic acid gas which existed in the limestone, and finally the material, as it becomes hotter, begins to fuse. At that point of incipient fusion the material comes together and form little

nodules of black material, called clinkers. That clinker is discharged in a hot condition, and it is stated that perhaps the temperature in the kiln that is necesary for this combination is perhaps 3,000 degrees Fahrenheit.

As the clinker comes out of the kiln it is elevated and dumped out in the open air or elevated and dumped in what are known as coolers, steel shells through which a current of cold air blows. The material as drawn from these coolers consists of black nodules that vary in size from perhaps that of a walnut down to that of a pea. This clinker is then reduced to a powder, whose fineness depends upon the specification of the man who is using it. The various technical societies have adopted standard specifications for cement, which prescribe that at least ninety-two per cent of that material must pass through a sieve having 10,000 meshes per square inch, and seventy-five per cent through a sieve having 40,000 meshes per square inch. Now that is Portland cement.

You can readily understand that the entire process is a chemical process which requires a chemist to see whether the material is of the proper proportion, and it makes little difference what the raw materials are, providing that in the mixture that goes into the kiln there is the proper proportion of silica and lime.

There are some objectionable ingredients that sometimes get into the cement; for instance, limestone that is high in magnesia is unsuitable, generally speaking, for the manufacture of Portland cement.

The complex reactions which take place in the rotary kiln are not understood to-day. Learned men, experienced in that kind of investigation, are trying to state just what combinations, what reactions take place, when the raw material goes into the kiln and is heated to about 3,000 degrees Fahrenheit. And after the material issues fro mthe kiln and is cooled and reduced to powder, we do not know exactly just what occurs, although sufficient investigation has been carried on to give us a fairly good idea of what occurs. It appears that a variation in the five or more ingredients that go into that material produce different combinations and different results. But, generally speaking, the cement is good.

We are to-day using in Portland cement a material which stands head and shoulders above any material of that character that has ever been produced. The Romans and all of the ancient races, with all their supposed superiority, never produced a material as good or as valuable as that we are using. And we use too much of it as a rule in our mixtures, but the conditions under which we use it make this excess necessary. Generally speaking, where there are failures, the failures are not due to the cement, and while they may be due to the sand or stone they can be more often ascribed to the workmanship or the bad treatment that it receives in the process of using.

I have been asked whether the German or English manufacturers make a more waterproof cement than is made in America.

Up to about 1890 most of the cement used in this country was of foreign manufacture, and there were a great many people who thought no cement equal to the foreign cement. Beginning about 1895, the American cement began to be manufactured in quantity and had a hard fight to overcome this prejudice. However, I think that about 1898 or 1899 it was pretty well established in this country, at least along the eastern coast, that the American cement was equally as good as the foreign; and to-day the quality of the American Portland cement is no longer questioned. The Germans are coming here and copying our methods, and we are beginning to show them something in the art of manufacturing Portland cement. But there is just this to be said about the foreign cements and their advantages, although better waterproofing qualities is not one of them, for a good American cement will make the material with which it is mixed just as waterproof as any German brand. The mere fact that the cement is made abroad and has to be shipped to a dock where it can be loaded on vessels for transportation here, which may take perhaps two weeks time, gives it an advantage over the American cement. It means, then, that the man who uses the foreign cement will get the older material, and therefore the better seasoned cement. The manufacturers in this country have large warehouses, and it is their general practice to see that the cement is made and stored some time before

it is used, simply that it may season, because the process of hydration, as I have been telling you, goes on, and the cement is not quite so active. You can manipulate it before setting begins and it gives you a little more time to get into the work. In the strenuous pace that is set by the consumption to-day, in which the cement is used almost faster than it can be produced, there is naturally a tendency to get the cement on the market as quickly as possible, to fill orders, so that there are perhaps times when the cement is not as well seasoned as it should be. But under the same conditions the American cement is as good and generally far better than the foreign product.

MR. F. K. HOGUE.—Will the use of hot water in mixing concrete for blocks have a good or an evil effect on the product:

PRESIDENT HUMPHREY.—Heat accelerates the process of crystallization. That simple little experiment with a solution of salt of which I spoke but a moment ago will illustrate this. If, instead of setting the solution on a stove, it were placed in a cool place, crystallization woul dtake place much more slowly, and if the temperature were low enough might stop altogether. The same principle applies to Portland cement, and if you take warm water you will simply accelerate the hardening. You can place cement in an atmosphere of steam with water and it will harden up quite quickly, due to the more rapid crystallization. The hot water in itself would not injure the cement, although the more rapid setting might prevent its being placed before commencing to harden.

A MEMBER.—For use in concrete blocks, are these so-called white cements just as safe as the others, or are they adulterated?

PRESIDENT HUMPHREY.—I think there are one or two cements known as white Portland cements that are coming on the market. There has been for a long time a feeling that there is a market for the white Portland cement, since in laying up monuments or stonework the dark color of the cement is sometimes objectionable. The reason for this cement not being on the market in large quantities is the difficulty of manufacture. If we took pure silica or sand and pure lime, the two materials would be refractory; that is, it would be difficult to attain the

temperature at which the silica would combine with the lime, and nature provides iron and alúmnia, which are known as fluxes, to bring about a condition in which the silica will combine with the lime readily. Now, in the manufacture of white Portland cement, there must be an elimination of the iron, because it is the iron that colors the cement, and as a general rule the more iron there is in cement the darker it will be. So the principal involved in the manufacture of the white Portland cement is to so select your natural materials that you have very little, practically no iron, in it.

The cost and difficulty of making a barrel of cement with a material so refractory as pure silica or pure lime are so great that the price per barrel would put it out of business, though I have no doubt that white Portland cement will be used when they can make it cheaply in quantity.

MR. L. B. WILLIAMS.—I would like to ask if Portland cement used in brick form would withstand the heat if used to encase a boiler, including bridge walls and all that?

PRESIDENT HUMPHREY.—Whether the cement will withstand the heat or not depends entirely upon the temperature, since if a sufficiently high temperature is reached the water of crystallization is driven off and the cement crumbles to powder. This temperature may be reached around the top of the steam drum, where there may be superheated steam.

MR. HOGUE.—Will a block made of gravel concrete withstand fire?

PRESIDENT HUMPHREY.—Gravel is formed by the decomposition of some form of stone, probably eroding by rolling. In this section of the country we have a kind of gravel which is of glacial origin, and is composed of particles of quartz and granite, and of limestone, probably to the extent of forty or fifty per cent. Along the eastern coast there is a gravel which is composed almost entirely of quartz particles, or the ingredients of granite. Now, those two materials are known as gravel. Probably, as regards strength, they may differ a little, but so far as their fire resisting qualities are concerned, they differ very radically, and it is manifest that the gravel which contains the larger percentage of limestone particles will be disintegrated under the

action of heat. The carbonic acid gas will be driven off and the limestone particles reduced to lime which, upon the addition of water, will swell and disintegrate the block.

MR. STANLEY.—On the south shore of Lake Erie we have what is known as boulder quartz gravel, locally called the Erie shale, which is composed of the hard material remaining when the shale disintegrates. I would like to know if there is any lime in that shale gravel.

MR. HUMPHREY.—There probably is some lime present, but in what quantities I do not know. Generally speaking, the character of the gravel will naturally have an important bearing on the strength of the concrete. In some parts of the country a crushed shale is used in concrete instead of crushed stone, but it is not a desirable material to use, as the very large percentage of fine dust has the effect of deadening the concrete.

A MEMBER.—I would like to ask the President if the so-called slag cements are recommended for blocks or for sidewalks, or for both?

PRESIDENT HUMPHREY.—After all the iron is run from a blast furnace, making iron by the basic process, the slag that remains is often drawn off and granulated by being chilled with cold water. When the lime and the silica and the other ingredients are in the proper proportion that material ground with hydrated limes forms cements of more or less good quality, called Puzzuolana or slag cements. Some of these are absolutely worthless and some of them are good.

This slag, which contains silica, iron, alumina and lime, can, on the addition of a little more limestone, be burnt in a rotary kiln to make Portland cement. The product thus obtained is not a slag cement, although the material which forms a part of the mixture used may be slag; but the mechanical mixture of slaked lime and slag is known as slag cement. I would not recommend the use of slag cement for blocks, although some of it may be good.

A MEMBER.—As there are some sidewalk men here, I would like to know whether there is any advantage in keeping a sidewalk covered and sprinkled after it is built.

PRESIDENT HUMPHREY.—If a good sidewalk is desired, care must be taken that it harden slowly and that enough moisture is

supplied. By covering and keeping moist you prevent the sun or dry air from drawing the water from the concrete and retarding or preventing proper setting taking place.

MR. STANLEY.—We have left our walks uncovered with good results, but I think it is due to the fact that we use perhaps more cement in the top coat than what is generally used, 3:5 or 1:2, and make our top coat quite wet, although not as wet as in the wet process. I believe that the reason some pavements crack when not covered is because an insufficient amount of cement is used in the top coat.

WATERPROOFING CEMENT MORTARS AND CONCRETES—THE ASPHALT MASTIC METHOD.

By H. Weiderhold.*

By invitation of your President, I have been asked to speak to you to-day on the subject of "Waterproofing." It is especially gratifying to me to be asked by a gentleman who has known me for a long period of years, and who knows the nature of the work that I have done as manager of our company.

One of the largest pieces of work done in the City of Brotherly Love was the widening of Delaware Avenue, and in connection with the same the concrete sea wall along the Delaware River, which was done by our company while your President was with the Department of Public Works. Hence I am justifying in supposing that our efforts at that great piece of work, as well as at others which came under his immediate attention while he was connected with the Department of Public Works, were approved by him, and hence warranted him in conferring upon me the honor of addressing you to-day.

Waterproofing, and especially waterproofing with asphalt mastic, is my theme. I have had the pleasure of speaking to various engineering societies; yes, even to the Western Society of Engineers in this city, on the same subject; but I have never had the opportunity of addressing a body of men of my own stripe; men who not only plan in their cushion covered office chairs ways and means to do a certain difficult line of work, but on whom it devolves to go and execute these various tasks. You all, indeed, have experienced that to plan and devise a piece of work is one thing and to execute it is often quite another.

We all, I know, swear by cement, and some of the older ones, among whom, I am sorry to say, I have to count myself, know how foreign cement dominated this country and what a hard fight we had to wrest the supremacy from the foreign manufacturer, and how we finally succeeded. But I am proud to say

*Manager Vulcanite Paving Company, Philadelphia, Pa.

that to-day American cement, made from America's own native product, in American mills, and by American ingenuity, now rules our market. Yes, I may go further and say that it is making vast inroads into foreign countries and is proving a strong competitor to English and German cements. In our own country I might say that we have driven them from their last ditch.

What immense progress has been made in the use of cement is known to you all. To say that the whole usage of cement has been revolutionized is putting it mildly. Who dreamed ten or fifteen years ago that we would rear skyscrapers, build bridges, and do almost everything imaginable with cement, or make inroads on steel and stone construction?

You must admit that too often in your work the time has come when you were compelled to find some material which would waterproof your foundations for buildings or waterproof your bridges; keep out dampness; not easily disintegrate when in contact with water; not be affected by climatic changes, and which stands heat and cold without cracking; protecting your iron constructions, no matter of what nature they be; meeting requirements for sanitary floors, water closets, kitchens, sub-basements, breweries, and, in fact, for any kinds of floors where water is used to a great extent, and where floors have to be water tight. You all know, as well as I, that cement will not and cannot fill the bill.

In order to obtain the best results for waterproofing I have tried various materials, and I shall give you my experiences of the last twenty-five years in my researches in this and foreign countries. But do not think for one moment, however, that I shall use the courtesy extended to me of speaking to you to-day as a cheap advertising scheme for any certain material. No, gentlemen, I would not violate in that manner the common rules of etiquette. The material of which I am going to speak is in the open market and can be bought by all of you in the same manner as any other product.

Asphalt mastic I have found to be the most efficient material for waterproofing. Now, a great many of you have used asphalt mastic and know all about it, but I have found by experience

that there are also a large number of architects and men in the business who know little or nothing about this valuable material, and this was my reason for delivering the various lectures on the subject.

I shall refrain from reciting to you how asphalt mastic was used in the olden times, how even the fishermen of Galilee used it to make their boats water tight; in Greek it was called "asphaltos," in Latin "bitumen," and in German "erdpeck." I shall not tire you with a lot of ancient history, as we are dealing with the present and not with the past.

Rock asphalt is found in Val Travers, or Val de Travers, in the Canton Neuchatel, Switzerland.

In Seyssel on the Rhone, in the French department of de l'Ain.

In Lobsann, a little village of the North Elsass.

At Limmer, a small town near the city of Hanover.

At a small town, Vorwohle, in Braunswick.

And at Ragusa, on the south coast of Sicily.

The rock asphalt of the above mentioned different mines consists of about 70 to 85 per cent of carbonate of lime, 8 to 15 per cent of bitumen, a small proportion of oxide of iron, and a small proportion of carbonate of magnesium.

The proper and only way to prepare the asphalt mastic correctly—by this I mean the marketable article which is ready for shipment or use—is in the first place to have the rock, as it comes from the mines, picked and sorted, and to have those portions of the rock which are not thoroughly impregnated with bitumen thrown to one side. With a little experience and judgment this can easily be done. The rock, after being broken into pieces, either by machinery or hand, to the size of about nut coal, is thrown into a disintegrater and pulverized to a fine powder. The flux (neither light volatile oils nor coal tar, but a flux of pure bitumen, refined from the best possible asphalts, Bermudez or Trinidad) in propor proportion is placed in specially built melting tanks and subjected to indirect heat and continuous agitation; and, after being thoroughly heated and made perfectly fluid, the pulverized rock is added to the same. The kettle is now closed, and this mixture is left to cook for from four to six hours, at a

heat of at least 250 to 300 degrees Fahrenheit. An experienced eye knows when the mixture is ready to be drawn off into molds. These molds are either square, round or octagon in shape, according to the manufacturer's trademark, and each one having a capacity of about 50 or 60 pounds of mastic.

After the mastic so drawn off has sufficiently cooled, and having been stamped with its brand, it is taken from the molds and is now ready for shipment.

I cannot help but express that, in my estimation, it is by far the safer way to import the rock in its crude state to this country and manufacture the mastic here, rather than to buy the manufactured article, as in the latter instance you are more liable to buy a "cat in a bag," as adulteration can easily be practiced on you by your European brethren. Especially have I been strengthened in this opinion since my last visit to Europe.

The prepared asphalt mastic is now ready to be brought into use by the asphalt mastic operator, and now the judicious manipulation by the experienced workmen begins. Placing the right amount of mastic, fluxing the same with the proper ingredients, adding the right amount of grit, and perhaps some sand, just as may be required by the proposed work, the material is kept cooking under continual stirring, and is ready for use whenever a wooden stick inserted in the mixture comes out perfectly clean, no material whatever adhering to it. It is then spread with the help of wooden spatulas or floats, to the required thickness on the prepared foundation, and, after having cooled sufficiently, is rubbed with the help of fine sand and sandstone to a smooth surface.

By no means am I, or anyone familiar with the mixing of the mastic, able to give you a uniform mixture to be used for all floors and waterproofing. The mixture depends entirely on what use the floor is to be put to, as it requires different mixtures for various purposes, and it is here that the experienced workman comes in.

Great care must be taken to ascertain what is required of the floor to be laid; whether it is to be used under or out of water; whether acids, if so, what kind, are to be used on the same, whether the room is to be kept cold or warm; and, in fact, only

after taking everything into consideration, can the mixture be decided upon.

An asphalt floor, by long odds, is more advantageous and will yield better results in cellars or ground floors where the moisture of the underlying ground may affect the floor.

Also a cement or any other floor absorbs the moisture, and takes a long time to dry if cleaned with water. To verify this assertion I had a piece of cement pavement one foot square by one inch thick weighed when perfectly dry, and found that it weighed 20 pounds and 12 ounces. I then laid it in water for a period of twenty-four hours, and again weighed it, and found that it had absorbed 1 pound 8 ounces, making a total of 22 pounds 4 ounces.

I did exactly the same thing with a piece of asphalt mastic flooring of the same size, and in twenty-four hours it absorbed only one and one-half ounces.

Natural deposits of rock asphalt have also been discovered in our own country, namely, in Kentucky and in Indian Territory. Our company has gone to a great deal of expense in experimenting with these rocks; yes, we shipped right into this city at a great cost a car of rock from Indian Territory, and I myself experimented with the same, and we found that rock from either Kentucky or Indian Territory will not make good asphalt mastic, and as much as we dislike, we must depend upon the product of the European mines for pure rock and rock that will not disintegrate.

In my experience I do not know of any material in existence that has been so much sinned against as asphalt mastic. Any one who has money enough to buy a barrel of coal tar and a pot to melt it in can mix this material with sand, and then call it genuine rock asphalt. Cheap oil asphalts are often used in the production of asphalt mastic, and the unsuspecting architect and general contractor are deceived. If work done with this kind of material does not turn out to be water tight or disintegrates in a short time, asphalt mastic is condemned, and is pronounced no good. I, however, positively defy contradiction, may it come from an architect, an engineer or a worker in asphalt mastic, when I say that if genuine asphalt mastic is used, it will do all

that I claim it will. Still your architect will tell me, "I have specified asphalt mastic; yes, I have even gone so far as to use specifications made by you, and still it did not do the work." Your general contractor will say, "I have used asphalt mastic and it has fallen far below what I expected it would do." I have asked, and do ask now, whether you have used genuine rock asphalt, or something which has been panned off on you as the genuine article. I assure you that in every case that did not give satisfaction some other material than asphalt mastic was used. To prove to you that I mean just what I say, let me cite to you a few of the many instances which have come to my observation during my business career, and which I can substantiate, if so desired, by giving the name of the architect, the building and the place.

A large tunnel was to be constructed from one building to another in one of our principal hospitals in Philadelphia. It was to be used as a passage way for the nurses, and also to carry the steam pipes from one building to another. Asphalt mastic was specified for the waterproofing. The contract was given to a contractor for less than it would cost for the material. After the work was finished and the steam was turned on, the heat naturally caused contraction in the cement walls down to where the waterproofing was placed, and before long the beautiful, so-called pure asphalt mastic began to run out in little streams on the floor of the tunnel, and the nurses and attendants naturally carried this so-called liquid asphalt mastic throughout the building and into the sick chambers—a very pretty state of affairs. This architect insisted on my going with him to investigate the cause. I was satisfied and could have told him what had caused the trouble before we went, but to please him I consented to go, and I found exactly what I had expected. To convince him that no asphalt mastic had been used I just held a lighted match against some of the material and the odor and the way it ignited soon convinced him that the supposed waterproof asphalt mastic was nothing more than coal tar mixed with sand.

A certain architect who prides himself on having built more Y. M. C. A. buildings in our part of the country than any other architect, designed a Y. M. C. A. building for Coatesville, Pa.,

and one for Niagara Falls, N. Y. Naturally, every Y. M. C. A. building has to have a swimming pool. These building were built and we were asked to bid on the swimming pools. On the swimming pool for the Y. M. C. A. building at Coatesville we bid without success, on account of the price. Coal tar or oil asphalt is cheaper than asphalt mastic, and our bid was considered too high. The first time the hot water was turned on the glazed brick, which formed the inner lining of the pool, back of which the supposed asphalt mastic was laid. The architect came to me and in a surprised manner said: "I used your specifications."

My natural answer was: "I am exceedingly sorry, but pray did you use asphalt mastic?" Out from the architect's pocket came a sample of what he supposed was genuine asphalt mastic. It did not take a chemical analysis to determine what the material was. Pardon me for using slang, but I had been up against it before, and my lighted match again did the trick and convinced the architect the asphalt mastic had been made out of oil asphalt. Just about that time we were again called to Coatesville by the president of the town council, and on meeting him he informed me in a pleasant way that the two reservoirs which we had lined eight years ago for them had stood so well and had not cost them one dollar of expenses during all these years, that they desired to give us the third reservoir to line with asphalt mastic. I used this opportunity to investigate the swimming pool in the Y. M. C. A. building at Coatesville, and the least that I can say is that it was a pitiful sight to see the otherwise well constructed swimming pool completely spoiled by the use of improper waterproofing materials.

We did the work of waterproofing the subway in Philadelphia from Fifteenth Street to the Schuylkill River, and so far not a single leak has been found. When the second portion (that is, from Fifteenth Street east to the Delaware River) was to be given out, strong influence was brought to bear by a paper and compound company, and I had no light task in convincing the officers of the Philadelphia Rapid Transit Company that paper would not do.

You all know that to hold up the roof of a tunnel there must be placed at certain intervals supports of heavy timber and the

waterproofing must be done around these supports. After the waterproofing has sufficiently hardened the supports are moved on the waterproofing and the spaces which they occupy have then to be waterproofed. This you can readily see cannot be done effectually with paper. It would simply mean a patched job, and we all know that a patched pair of pants is not as good as those made out of the whole cloth.

It is quite different with asphalt mastic, however, as all that is needed is to heat the sides of the first laid mastic and then apply new asphalt mastic, and you can make a joint which the most experienced mastic layer afterward cannot find, and in that way you get a perfect continuous sheet. On this very essential score we were awarded the contract for the second portion of the subway, and we are now laying asphalt mastic from Fifteenth Street down to the Delaware River over the whole length of the tunnel.

The subways in New York and Boston are lined with paper and asphalt compounds and you can readily ascertain whether they are water tight. As we laid all the cement work at the various underground stations of the New York subway, I can say from my own observation that this tunnel is not water tight.

About nine years ago we laid a saw-toothed roof on the Fidelity Building, Philadelphia. On the sharp incline five-ply paper and compound were specified, while on the other part of the roof asphalt mastic was specified, and over all this was laid a layer of cement. Sometime ago a leak was sprung in the roof. and on cutting down the cement we found the asphalt mastic intact, and in the same condition as when we laid it, but the paper had disintegrated and caused the leak.

I could tell you a number of experiences that I have had with waterproofing with paper and coal tar or asphalt compounds, but I simply wish to say that we give a guarantee with all our asphalt mastic work, but we refuse to give any guarantee with paper.

Another one of my experiences which I wish to cite to you is in connection with the swimming pool for the Blind Asylum at Overbrook, near Philadelphia, which was to be built last summer in connection with the bowling alley. We bid on this work.

and the contractor wanted us to build the pool, but our competitors bid so low that we could not possibly do the work at their price, hence we lost the contract. The first contractor did his work in such an unsatisfactory manner that the architect made him relinquish the contract. Another party next tried his hand with burlap and compound, but was so unsuccessful with his work that it leaked like a sieve and we were called in to do the work. We began by tearing out all the materials and lined the pool with asphalt mastic. We have now completed the work and have guaranteed it for five years.

When waterproofing is to be done in places where there is considerable water pressure we find that there is only one method to pursue. While doing the work relieve the water pressure by pumping from a lower water level. Build your bottom and outer walls of sufficient strength to receive the asphalt mastic waterproofing or lining. Then build your concrete bottom and inner brick or concrete walls on top of the asphalt mastic lining and of sufficient weight to withstand the water pressure from without, and your task is done.

At the new Wanamaker Building, in Philadelphia, we are building approximately 1,700 lineal feet of pipe ducts below the sub-basement floor, which are almost completely submerged in water. We are building them in the manner above described with the best of success.

I speak, as stated above, from experience, and I could easily recite to you many cases where we have been called in to the work where others have failed.

Before I close, I wish to state that I have with me samples of crude rock asphalt, and also of asphalt mastic in marketable form, as well as pictures of some of the work which we have done, and I shall be only too pleased to show them to anyone who wishes to see them, and if any of my remarks need further explanation to anyone I shall be only too glad to have them question me, and if I have spoken disparagingly of anyone's materials I am sorry, but I was called upon to tell you my experience, and I have done so without malice.

I thank you for your kind attention.

DISCUSSION.

MR. ANDREWS.—I would like to know what thickness of asphalt is used on walls and on the floors and what it costs?

MR. WEIDERHOLD.—We find that one inch for the bottom and one and a half inches on the side is sufficient. Sometimes the architect is inclined to specify two inches, but I believe it is a waste of material. The cost of the mastic in the vicinity of New York for a one-inch layer ranges from 15 to 20 cents to perhaps 25 cents on the sides.

MR. A. C. HORN.—I would like to ask Mr. Weiderhold what percentage of all the waterproofing done in this country is by the mastic process.

MR. WEIDERHOLD.—That is a pretty broad question, but to the best of my knowledge, most of the waterproofing is done with paper and burlap.

MR. HORN.—I am a waterproofing contractor and do a very large amount of work in the City of New York. I have waterproofed the Times Building forty-seven feet below grade, and under a heavy water pressure, and I am now waterproofing the Bellevue Hospital, which is on the East River and have in consequence a heavy water pressure to contend with. I have waterproofed tanks for the School of Mines, Columbia University, of New York, and also the building of the Savings and Trust Company, of Columbus, Ohio. In all these cases I have them successfully watertight by the paper and compound method.

Because one man has had a failure, it does not follow that the method is worthless.

In my experience, I have found jobs done with mastic which have failed, as, for example, the roof of the Rodgers Peet Building in New York. I do not condemn the mastic, it is an excellent method, but its cost is prohibitive in most cases.

WATERPROOFING CEMENT MORTARS AND CONCRETES—THE ELASTIC VS. THE RIGID METHOD.

By Edward W. De Knight.*

The importance of waterproofing in these days is not so much in keeping water out of buildings as in protecting and preserving the imbedded steel.

What is first necessary is to determine upon method, and having done that, then decide upon materials. In looking over the field it will be found that all waterproofing efforts are divided into two totally dissimilar lines of action, viz.:

1. Treating concrete to make it, in itself, impermeable.

2. Protecting concrete or masonry with something apart therefrom to waterproof them.

Aside, therefore, from any consideration of *materials,* it will be found that the question dividing these two dissimilar lines of action is one of method, *i. e.:*

Shall water reach the concrete, or shall it not reach the concrete?

We will first consider:

Treating Concrete to Make It, in Itself, Impermeable.

Under this head come those materials and methods for making concrete impermeable—first, by mixing certain chemicals with the concrete for the purpose of making the solid mass impermeable; and, second, by applying a coating or wash to the hardened surface of the concrete, or applying thereto a cement plaster. The ingredients generally used are lime, silicate of soda, lye, soap, alum, etc., etc.

Among many objections to the first process is, that the mixing of the chemicals with the cement will not lessen the present general difficulty of having concrete properly mixed in the field. Without, or with, the chemicals, therefore, there will always

*Manager Hydrex Felt Engineering Company, New York.

exist zones weak in quality and density. The second objection is the uncertain effect the addition of the chemicals will have in time upon the concrete—and particularly upon the imbedded steel.

One of the chief, among numerous, objections to the second method—*i. e.,* using coatings or washes—is the poor judgment in basing dependence for permanent waterproofing upon *one* thickness or layer of any single thing—which in this case happens to be a wash almost imperceptible in its thinness. This, aside from any consideration of the fact that but one infinitesimal pore imperfectly closed, by permitting the entrance of water—which would soon spread—would make valueless the balance of the washed surface. Such treatment is not even consistent with the doctrine of *similia similibus curantur,* because we are not curing like with like—but adding a bad thing to a bad thing.

Most seriously, however, neither of these methods make any provision whatever for the cracking of concrete—which is entirely overlooked. That concrete *will* crack is indisputable. That it can be made impermeable is possible. Why, however, make it impermeable if its impermeability will not prevent cracking, or provide waterproofs for practical, every-day conditions? Are not, then, the extensive laboratory tests as to the waterproofness of briquettes and water-filled boxes of cement, or tubes filled with water whether under 10 or 50 feet pressure, resting on blocks and cubes of specially treated cement—an expenditure of time and energy in the wrong direction—at least from the viewpoint of practical waterproofing? Would it not be impossible to extend into monolithic form in the field, concrete so perfect in texture and mixture as the specially prepared laboratory sample? Masses of concrete in the open, especially in this climate, where the temperature ranges over 120° F., are subject to inequalities of settlement, contraction and expansion, and other conditions impossible, to the same degree, in a laboratory sample.

Testing the strength and quality of cement, as cement, is a different thing.

We have seen water drawn up fifteen or twenty feet by concrete. We have also seen water come through concrete over

twenty feet thick. It may take two or three years to do so; meanwhile the assumption is that the concrete is fairly water-tight. But, with the average concrete, water will come through it *in time*. When the concrete thus becomes damp, wet and saturated with moisture, it is impossible to get the moisture out. If the moisture freezes—expanding ten times its volume in so doing—it requires no stretch of imagination to calculate the effect upon the concrete or masonry. Enough water will be taken in through a crack, *before the crack is filled,* to attack and injure the steel. Filling the crack after that is simply patching without curing.

It has often been, not facetiously, but seriously, suggested that all that is needed to solve the difficulty is for some one to invent something to fill the cracks and make a water-tight joint—with special reference to structures above ground level. The United States Patent Office will not entertain an application for patent or an invention claiming perpetual motion, on the assumption that there is no such thing in mechanics. A perpetual crack filler which will make a crack water-tight under a temperature of 120° F., in August and 20° F. below zero in January, is beyond the pale of possibility—or even perpetual motion.

We sincerely believe that a great deal of harm will come to the cement industry from the indiscriminate use of the numerous preparations on the market for hardening the surface of concrete, or, in other words, for the purpose of making the concrete impermeable. We think that this has been already observed in attempts to make concrete blocks impervious by the use of such preparations, and the recommending and using of such blocks for situations and purposes for which they were never intended. Some of these waterproofing preparations are practically worthless, while the bulk of them, we think experience will later show, are of but passing value. Their use simply temporizes matters instead of permanently curing them. We understand that one of the most extensively used of these preparations was originally intended by the inventor to lessen the absorbent quality of cement or concrete, and *not* for "waterproofing" foundations, arches, walls, floors, etc., in the every-day, practical waterproofing sense.

Even though liquid glass were spread over the surface to be waterproofed, it would not serve for practical waterproofing, because, while glass would, of course, be in itself water-tight, it would readily crack with any jar, contraction, expansion, settlement, etc., etc.

Another thing. The majority of these preparations, cement plasters, etc., are placed on the inside surface of the wall.

It is against the logic of things to place the waterproofing in front (where in time it can be shoved off) of the line of resistance (the wall) instead of behind it. One of the chief uses of waterproofing is to keep water entirely from the wall—instead of allowing it to come to and through it—and by capillarity work up and saturate the entire wall, and in the course of years press off the hardened cement or other coating on the other side, which it must finally due by the very law of nature.

Of what use is a waterproofing which will not accommodate itself to the wall, instead of having the wall accommodate itself to the waterproofing (*i. e.,* of having the owner guarantee that his wall will not crack the waterproofing). Waterproofing is applied to protect the surface waterproofed under all conditions—settlements, jars, shocks, expansion, contraction, heat, cold, water, snow, ice, etc. To accommodate itself to and protect the wall or other surface under above described conditions is exactly what the elastic "membrane method" does, and what the rigid cement method, by the admission of its own exponents, does not and cannot do. It matters not, then, how durable may be the cement.

Further, in addition to the undesirability, on general principles, of permitting water to soak through the entire wall and gradually work its way upward, the presence of moisture or water in the wall constantly pressing against the thin layer of cement plaster on its inner surface is to make the entire wall, including the cement coating, so cool or cold as to make it difficult, if not impossible, to heat the wall and prevent condensation thereon. As it will be also practically impossible to drive the moisture out of the wall, the condition will grow more serious with time. As furnaces and boilers are placed in the foundation, and heat draws water instead of driving the water out of the wall, it will tend to draw it through it. All this aside from

any consideration of the cracking of the cement itself. On the other hand, the "membrane method" not only insulates the wall against the surrounding earth, but keeps the water entirely away from and out of the wall, making a dry wall susceptible of heat or warmth and preventing condensation thereon.

Why permit the saturation of the wall and the consequent corrosion and slow but sure destruction of the imbedded steel?

On careful consideration, therefore, does it not seem absolutely necessary that we get *away* from the concrete, and so protect it that water will not reach it? This protection standing between the water and the concrete will then make it permanently water-tight, whether it cracks or not.

Protecting Concrete, with Something Apart Therefrom, to Make It Waterproof.

Under this head come those materials and methods for preventing water from coming in contact with the concrete. Practically the first efforts in this direction were to coat the surface to be waterproofed with the coal-tar-pitch or asphalt, which, however, when set and cold, cracked and separated with any settling or cracking of the masonry. Burlap was subsequently used to reinforce the pitch or asphalt, without, however, preventing them from cracking, and the burlap, being of itself not waterproof, did not give waterproofness. Later on there came into use for this purpose tar paper, which, however, lacks pliability and tensile strength. Tar and tar paper have been extensively used for waterproofing in the past, simply because there was nothing else open to the profession. It was not until recent years that any serious effort was made to place waterproofing on a scientific basis—and to make materials specially adapted to the various conditions—materials which would not become brittle or be injuriously acted upon by water, the salts in the earth, alkali in cement, etc. The result of this specialization has been to greatly improve methods and to open to the profession products for difficult work and special conditions, considerably in advance of old-school materials.

There are also used for waterproofing, mastics composed of coal-tar-pitch, or asphalt, mixed with sand or torpedo gravel, re-

sembling somewhat, when finished, an asphalt pavement. Mastics on floors, especially on bridge floors, soon separate from walls, steel columns and girders. If the mastic is made soft enough so as to not crack in winter, it becomes too soft to bear the load of traffic in summer. The chief objection to mastics is that they crack clear through with any contraction and expansion, or cracking of the masonry or concrete surface, of which they become an integral part when applied hot thereon.

Specifications also frequently require that the interior surfaces of foundation walls and floors shall be given one or two coats of some waterproofing paint. The paints might be excellent materials in themselves, but their use for such a purpose is a sheer waste of time and money, as they cannot possibly prevent, for a number of obvious reasons, the percolation of water through the wall, or protect the imbedded steel. There are also now on the market a number of what are termed "textile" waterproofing materials, which, on examination, will be found composed, in many instances, of simply burlap, *i. e.*, ordinary commercial bagging. The fibre is vegetable; is extracted from the bark of trees, and is very perishable, especially in underground conditions. The apparent strength of such materials misleads one into using them, whereas strength alone is not, by any means, the first essential in a waterproofing material. These saturated textiles or baggings are, in a measure, going backward to the old-school method of incorporating burlap with pitch or asphalt, to reinforce it as steel reinforces concrete. There is a clear distinction, however, between the principle and results to be obtained in reinforcing concrete with steel, or reinforcing waterproofing with burlapped textiles. The two should not be confounded. Otherwise it would be advisable to reinforce bitumen with copper mesh. The treated or saturated burlap is no more waterproof, especially for water-pressure work, than when originally used to hold pitch or asphalt on a wall. This can be easily tested by placing a single sheet of thickness of the treated material under the slightest water pressure, when it will be found, within a few hours or days, that water easily passes through the interstices of the material. A woven fabric has never proved superior for waterproofing, even though it be canvas, because the

fibres pull against instead of with each other, resulting in the opening of the interstices and the usual splitting of the fabric.

The best material is unquestionably a strong, fibrous *felt*, made in itself, *i. e., in one sheet*, absolutely impervious to water by a process of saturation and coating the materials specially adapted to withstand the injurious action of water, and particularly all underground conditions. It is then practically an impervious membrane or skin, through which, of course, in one sheet, water will not pass. As many layers thereof, as the conditions require, can be then cemented or veneered together, with a waterproof, bitumen-cement, not too weak, or hard and brittle, for the felt, but as strong and elastic as the felt. This forms a waterproof stratum so strong, tough and pliable that, without injury, it can be readily bent, turned, twisted, etc.. Whether in a building, foundation, covering the floor of a bridge, or enveloping a tunnel, it readily conforms to the final conformation of the surface waterproofed, of which it is practically a part, and which it insulates and protects under all conditions—settlement, jars, shocks, cracks, expansion, contraction, heat, snow, ice, water, etc., etc.

The speaker has termed this *"the membrane method,"* and firmly believes it the basis for the development of a perfect waterproofing.

The speaker, some time ago, advanced the theory that our structures should be treated, in the waterproofing sense, as things that live—*i. e.,* things that *move.* We would again, therefore, go back to locate some first principle of natural law as a guidance. There is nothing made by man that its prototype in some form is not somewhere in nature. No man ever invented a color. No man ever devised an insulation for the most intricate electrical machinery as perfect as the insulation of the human brain—the dynamo of the universe.

In seeking a guide, therefore, in our present problem, we find no waterproofing throughout nature which is hard, or set, or vitreous, because nature waterproofs only living things (things that move)—not dead ones or inorganic ones, which do not require it, but by moisture, heat and decomposition are resolved back into carbonate of lime. Therefore, all things that live and

move require, and are by necessity protected with a flexible. elastic skin, yielding to growth, movement, action. Therein lies the origin, the first principle, of waterproofing—natural or artificial. Can any other principle be right?

In the very beginning of germination nature begins to cover, insulate and protect with a film, skin or membrane, the life germ. This law prevails through the whole line of plant and animal life, from a grain of wheat up to a mastodon. Puncture this pratecting skin or membrane and there immediately ensues decomposition (or corrosion) in the exposed flesh. So long as the plant or animal lives, whether one or a hundred years, this yielding membrane perfectly protects. We ourselves take the tough hide and the fine elastic skin of animals to protect our feet and waterproof our hands—both our own and the artificial protection readily yielding to every movement of the foot or hand.

If a chicken came forth in a coating of soap and alum his usefulness would end with his appearance. Nor do we waterproof our feet or our hands by immersing them in a bath of cement, which would make them set, rigid and useless. Yet is this not essentially what we do when we protect and waterproof our structures, which must settle, contract, expand and move—with an injection of hardening fluid to embalm them, and thus prevent, instead of provide, for the natural functions of the masonry or concrete—thus imperiling both the waterproofness and the usefulness of the structure?

Obviously, therefore, a natural waterproofing is one which—skin, hide or membrane-like—yields to the natural contraction and expansion of the structure and protects it by preventing water from reaching it.

If, therefore, the skin or membrane theory is logical, natural and right, it then simply remains to scientifically develop and perfect the necessary materials on which depends the success of its practical operation.

Considered in this light and coming down to the actual work of preventing water from reaching the structure by the membrane method, we would submit the following observations and rules:

Practical Application of Waterproofing.

1. No waterproofing, especially for difficult and water pressure work, should be undertaken when the temperature is below 25° F.

2. Allow sufficient time, room and accommodation in which to properly apply the materials.

3. Design the structure to properly receive waterproofing, for the design will either make impossible proper waterproofing or will invalidate the best materials after they are in place.

4. Specify always that the waterproofing shall be done only by experienced and skilled labor.

5. Thoroughly protect the waterproofing during and after application.

6. Inspect waterproofing at all times during application.

7. Do not depend upon guarantees.

8. Do not use a set or standard specification.

DISCUSSION.

MR. HORN.—I believe all the manufacturers of waterproofing compounds agree with Mr. DeKnight that it is sheer waste of time and money to put the waterproofing compound on the interior of the walls, because we do not get the resistance the walls afford. If, however, we put the compound on the outside of the walls, the weight of the wall will be added to the resistance to the water pressure.

PRESIDENT HUMPHREY.—The chair thinks the explanation of the speaker is perfectly clear, and it is a simple proposition that a person will not attempt to put waterproofing on the outside if the pressure is coming from the inside, tending to drive it off.

MR. J. R. GILL.—One company that I know of which uses a kind of plaster for waterproofing, claims that if any cracking occurs in a coating applied to the outside of a foundation wall it means excavating before repairs can be made, while if applied to the inside it is easily accessible and can be repaired at much less expense.

MR. HORN.—There is a waterproofing system called the rigid system, which makes the same claim as that which Mr. Gill has just made, that if the waterproofing is not done properly down in the sub-structure and springs a leak, they can readily determine the location of the weak portion, cut an inverted "V" and repair the waterproofing; whereas, if it is done by the membrane system, it is put on the exterior of the wall and then covered by earth and back filling, and it would necessitate excavating all around to determine the position of the leak.

MR. DEKNIGHT.—We take the ground that the membrane method being quite elastic will not crack, and as a rule it does not crack. The gentlemen seem to have overlooked the fact that the point in the discussion is this: Why allow a wall two or four feet thick to be entirely saturated with water and then put your cement on the other side? As I said, the waterproofing is for

the purpose of preventing water from getting at the wall. Why put your waterproofing on the other side and allow the wall to become saturated?

The principle of the membrane method is based on a natural law that there is nothing in nature which has a waterproofing character which is hard or fibrous or rigid; and there is nothing in nature which is waterproof on the inside. If those two facts are true, and they are open for discussion, then any other method of waterproofing is wrong, no matter what it is.

MR. WIEDERHOLD.—I always find that the main question when I do waterproofing is whether I want to keep the water on the outside or want to keep the water in. For instance, in a reservoir I make the calculation how much water I have to contend with. Then I overcome that weight with the weight of the outside wall of concrete or brick or whatever it may be, and put my mastic on the inside if I want to keep the water in, as in a reservoir. If I want to keep the water out, then I simply build a shell of a wall against which I can place my mastic; then I put the heavy wall inside to sustain my mastic against the pressure of water from the outside. I believe that with any system of waterproofing the position depends upon the direction from which the water comes.

MR. DEKNIGHT.—The whole scheme of waterproofing, excepting tanks, etc., is to protect a building or wall. Now, to keep water in a swimming pool or reservoir, everyone knows you must line it on the inside, and yet I have seen a great many mistakes by eminent engineers who, in trying to keep water on the inside of a reservoir, put the waterproofing on the outside.

WATERPROOFING CEMENT MORTARS AND CONCRETES—THE DRY COMPOUND METHOD.

By R. R. Fish.*

In being invited to discuss the subject of Waterproofing before this convention, I was requested to avoid a talk that would appear as an advertisement for any special waterproofing material.

There are many methods in use for obtaining waterproofed results in concrete work, even though some of the methods give but temporary results.

There are, for example, a great number of washes on the market which are sold under the head of waterproof compounds, but we all know that even the best white lead paint exposed to the weather eventually has to be replaced, therefore I have no faith in waterproofing compounds applied in the shape of a wash. There is one serious objection to a waterproofing wash, which is, that the color of concrete work generally suffers from its use and the company I represent has on file letters to the effect that out of five or six different waterproof washes tried by responsible parties, none of them gave satisfactory results.

There are also the methods of waterproofing with paper, tar, asphalt, pitch, etc., and in work done under these systems it frequently happens that where the paper laps, leaks are found, and where pitch and asphalt and tar are used the concrete mass is separated and the strength of a floor or wall constructed of concrete is therefore impaired; for example, in waterproofing a concrete cement floor in a building asphalt is sometimes used between the bottom course and the finishing coat. This prevents the finishing coat from adhering to the bottom course and with heavy use, in time, such a finishing coat is liable to separate and break.

Mr. S. B. Newberry, who is unquestionably acknowledged as an authority on cement chemistry and the uses of cement, has

*Sandusky Portland Cement Company, Sandusky, Ohio.

made an exhaustive study of waterproofing concrete work and has arrived at the conclusion that the material used for waterproofing concrete must be a substance which in no way effects the strength, color or setting qualities of cement; at the same time it must be a substance which is embodied in the concrete mass.

There is considerable talk in the cement journals of elastic waterproof compounds and some engineering papers even go so far as to say that concrete work can not be waterproof until an elastic waterproofing material can be discovered; that is, one which will contract and expand with the concrete work, in order that no cracks occur that would permit the passage of water.

The material which I have here and which I intend to demonstrate to you does not absolutely fill the voids of concrete, nor is it necessary to fill the voids of concrete to make it resist water. The material here resists water sufficiently so that with the use of one to two per cent of the weight of cement employed, reservoirs, cellar floors, walls, concrete blocks and all classes of concrete construction can be made absolutely waterproof.

Some of the cement journals have recommended the use of soap and alum as a waterproof solution, and in regard to this would say that I recently superintended the waterproofing of the Herbivora building for the Cincinnati Zoölogical Company, at Cincinnati, Ohio. That building was constructed of reinforced concrete and the roofs of the building has received a treatment of soap and alum mixture. This did not give satisfactory results and the building leaked in every section.

The trustees of the building decided to sheath the roof with copper at a great expense, but the company which I represent and which manufactures the waterproofing compound I have here on exhibition, induced the board of directors of the Zoölogical Company to apply a cement mortar coat to the exterior of their building, this mortar coat to contain a 2 per cent mixture of this waterproof compound. I take pleasure in reading a letter recently received from the chairman of the committee on buildings and grounds, which shows the results obtained in the use of this material.

" 'The resurfacing of our new Herbivora building with your compound was completed early in this month and included all

five of the domes and supporting walls above the first story. The work has been in progress since October and has been slow and difficult, owing to the very complicated character of the roof surfaces, but the delay has enabled us to test it both with heavy rain storms and melting snow. The result is perfectly satisfactory under these conditions and there is not a sign of leak in any part of the roof or walls.

When we applied to you last September, these roofs, laid with concrete after the ordinary method, were leaking in every section and we were facing the problem of leaving the animals in their old winter quarters and were seriously considering the great expense of a complete metal roof next spring. Our committee was more than skeptical of its success with concrete in any form, and I confess that we undertook the responsibility of trying your compound with great reluctance. The result so far is all that we could desire, and if the roof does equally well under conditions of extreme heat and cold hereafter, we can ask nothing better.' "

Going back to the subject of an elastic waterproofing material, we would say that if concrete can be waterproofed at all, there is no material that can be added which will find its way to any serious cracks that appear in concrete structures or any material that can be used in any way to remedy such cracks, unless such cracks might be corrected by being filled with a cement mortar containing waterproofing material. There is hardly any danger of serious cracks occurring in first class concrete work, and therefore if the concrete is put in properly under a good superintendent and in proper proportions this waterproof compound, if used correctly, mixed dry with cement before sand and water is added, will secure for the engineer a perfect waterproof job.

Any question that any of the members present wish to ask in regard to waterproofing, I will be very glad to answer if I am able, and anyone sufficiently interested in obtaining waterproof results to care to experiment with the material that I have here, will be able to satisfy himself that it is the only dry substance on the market that will absolutely do all that is claimed for it and that will give permanent and perfect results as well as in no way effect the strength or color of concrete.

DISCUSSION.

Mr. Horn.—I want it distinctly understood before I begin that I am not attacking any material, that I am going to keep right down to the question of methods. Mr. Newberry has in this material a mixture which probably does waterproof concrete, but there are three elements that must be taken into consideration in arriving at a conclusion regarding the value of this material. First, he mixes his compound with Portland cement. You must, therefore, obtain a thorough chemical mixture between the compound and the cement; otherwise, you will not obtain a waterproof Portland cement. After that you must make your mortar, and there again you must obtain a thorough mixture, otherwise you will not have a waterproof mortar. On these two mixtures depend the success of the waterproofing that you can obtain from this compound. I might say with safety that those of you who are concrete block manufacturers or cement users, using it in various forms probably do not do your own mixing. You employ men for that purpose who, if they were above the ordinary average of intelligence would not be earning their living mixing sand and cement. So that you have there an element to contend with that at best is not very satisfactory.

The second proposition is this: In order to develop the greatest compressive strength of the block which depends on the thoroughness of the crystallization of the cement, you require first, a wet mixture, and afterwards continual wetting.

How can this be developed in a block that is absolutely waterproof, as it is claimed this compound will make a block. That is a question that I would like to have discussed.

I want it to be strictly understood that I am not attacking his material, for I am familiar with its chemical composition and I will say that it will shed water. But if it sheds water you cannot develop the full crystallization of the cement, and if you develop the full crystallization of the cement in spite of all the material, then it does not shed water.

MR. PARSONS.—I have used the material described by Mr. Fish quite extensively in the waterproofing of cement and concrete stone. After using 1 and 2 per cent mixtures of this material as recommended, and observing the action of the sun and atmosphere upon it, I found that with the 2 per cent mixture the water would stand upon the surface of the stone until all evaporated. I saw that would not do for the very reason that Mr. Horn mentioned, that it would prevent any moisture going through the face of the block, and if the stone was cured face up or put in the wall a little green, which sometimes is done in the haste to get it into the wall, it would not absorb sufficient moisture from the atmosphere or from the rain to continue the crystallization. I found that with a 1 per cent mixture the stone would be impermeable but not impervious. The surface would then act very much like the face of a brick, water would be absorbed but would not pass through.

Now that served a more excellent purpose in another direction, since not enough water penetrated the block to bring the salts causing efflorescence to the surface upon evaporation of the water, and the face of the block remained smooth and of a uniform color.

PRESIDENT HUMPHREY.—The cement in either mortar or concrete, in order to bind the mass together, must set or crystallize, and in order to crystallize it must be supplied with water. If the material be very porous and is exposed to dry air, moisture will be drawn from the mortar or concrete and the cement will not crystallize; therefore, it is the practice, commercially, to sprinkle the material so that it can harden properly. If the material is supplied with sufficient moisture when mixed, this water will be prevented from escaping from the block by any good waterproofing which is added to the cement as a powder, and I believe the trouble mentioned by Mr. Horn largely prevented.

MR. A. N. PIERSON.—I believe that waterproofing is largely taken care of as Mr. Newberry, Mr. Moyer and Mr. DeKnight have pointed out, by reducing the voids in the concrete. There is a certain amount of void that is necessary to carry some water for crystallization, but more than this is undesirable.

PRESIDENT HUMPHREY.—Commercially, we cannot build a long wall, even though the wall itself is perfectly dense, since concrete expands and contracts with change in temperature. One of our great troubles in the concrete walls of reservoirs is the fact that while the material itself may be tight enough, the cracks are the points at which the water flows through. I agree with Mr. Pierson that you can make a concrete wall practically watertight by properly proportioning the materials.

Under ordinary conditions it has not been found practical to make a block by the wet mixture, yet I do not believe that there is any man that uses the process who does not know it would be preferable to use wetter mortar or concrete, but there are practical conditions under which, if he makes it too wet, he cannot handle the block in reasonable time by the process he uses, nor can he get a block with a good surface.

MR. HORN.—It is possible to make bricks absolutely waterproof, but it is not done, simply for the reason that it is impossible to erect a strong wall with a waterproof brick, because the mortar will not bind one brick to another. The same thing is true of concrete blocks. So the question arises, do you want a wall that will absorb some water? Do you want to minimize the amount of water that the wall will absorb, or do you want to exclude it absolutely? If you want to minimize it and make it impermeable, you must have the proper mixture; if you wish to exclude it absolutely, use some material for doing that.

MR. WILLIAM SEAFERT.—Why is it thought necessary to use waterproofing in a two-piece block? It is a known fact that a good deal of waterproofing is used and is recommended by the manufacturers to their customers.

MR. J. R. GILL.—The only reason for its use in this system is, I believe, to prevent efflorescence on the surface of the block.

WATERPROOFING CEMENT MORTARS AND CONCRETES—THE LIQUID METHOD.

By G. G. Fry.

I have but a few words to say. I hope in time my waterproofing will speak more eloquently for me than I speak earnestly for it.

I speak earnestly because I believe a waterproofing to be a necessary and useful addition to that most desirable building material—concrete.

Probably no feature in the construction of office buildings, factories, apartment houses, bridges, residences, etc., has received more attention recently than the employment of concrete as a building material. The use of this material is becoming more general every day and new possibilities are opening up for it. New inventions and new materials are every day being put in the market for the advancement of concrete as a building material and yet the possibilities have not even been approximated.

One of the great drawbacks to the use of concrete in building is its porous nature—it absorbs dampness easily and retains it—therefore *something more* is needed to make concrete a *perfect building material,* and I claim that something more to be a waterproofing.

There are many reasons aside from the mere fact of waterproofing a building, why a waterproofing paint should be used upon the porous surface.

It not only makes the material waterproof but prevents it from discoloring, and by making it non-absorbent it virtually helps to keep a building clean.

There are few varieties of stone, either natural or artificial, that are not porous to some extent; even tiles and some marble will absorb moisture. As a consequence the exposed portions become discolored by the atmospheric conditions and more or less soot, dust, etc., is taken with the very structure of the stone by reason of the absorbent nature. Especially is this noticeable

of concrete blocks, which are very porous. These blocks when first made look clean, have a nice color and otherwise of good appearance, but upon being exposed to the weather they become discolored, looking old and shabby.

Not only concrete blocks and other artificial building material, but natural stone as well, discolors with age. One of the advantages, therefore, of a waterproofing paint is to retain the natural color of both artificial and natural stone.

The main advantage, and my last word, is the usefulness gained by making a building waterproof from without insuring a dry, healthful atmosphere within. Think of the advantage to hospitals, churches, factories, office buildings, to say nothing of the home from the garret to the cellar—and the roof if it be shingled with a cement covering.

The waterproof building is a comparatively new idea. The need for it is as old as the hills.

WATERPROOFING CEMENT MORTARS AND CONCRETES—THE HYDROCARBON PAINT METHOD.

By S. J. Binswanger.

The consideration of cement brings with it the proper mixture of this concrete form of construction and carries with it the desire to know all the requisites for damp proofing cement foundation walls as well as superstructure walls of buildings for residential or business purposes, and retaining walls.

It is useless to think that something of a stearic or paraffine nature mixed with hydrated lime, or talcum powder, in very finely powdered form and combined in a mixture of cement would shed water. This does not create a filmatic union with the cement particles, nor does it create a chemical union; hence, for a limited time, as a greasy article, it may as such shed water, but will be eaten up by the lime particles of the cement, forming a soap mixture, which is soluble and liable to penetration by moisture. Another article has come to my notice, a dry powder of an iron oxide base from the cheaper mineral paints and mixed with sal ammoniac or similar substance, so that this material will disseminate into and flow with the cement, trusting that such flow of the iron particles will permeate and fill the molecular constituency of cement in the form of a concrete construction. This material is an iron stain and its staining property is so great that paint or whitewash application on concrete walls which had been treated with this iron stain will be affected, nor could it in years be overcome.

A while since a very excellent gentlemen connected with a most reputable concern showed a sample of cement formed with a hollow to hold water, as an advertisement for a colorless liquid claimed to be waterproof or to waterproof cement and concrete mixture. The material with which the sample had been coated was nothing but a paraffine oil worth a few cents per gallon in barrels. Some foreign materials had been mixed with the paraffine oil to further mislead, so that this business concern was

selling a material at several dollars a gallon, or as near that price as they could get. The gentleman was told to try linseed oil, kerosene oil, or lard oil, or paraffine oil, or anything of that nature on several other samples that had not been previously coated, so that he could learn for himself that either one of these articles would temporarily help shed water.

It is a fact well known to painters, and to a more or less extent to builders; and architects also know that paints applied on the outside of a brick wall or a cement wall in a short time appear as if such coating is either eaten up, or washed off by the rain. Both results are the cause of paint not adhering to such wall, for the simple reason that the oil, or linseed oil in good paint, is not impervious to rainwater, hence the moisture mixing with the linseed oil and the lime salts or alkali in the cement as well as mortar joints, and the brick also, forms a soap mixture. You well know how home-made soap is made from grease drippings, alkali and water. The soap mixture formed on the wall is soluble and is readily washed off by successive rains; therefore, it is necessary to look for a coating impervious to such influences, and alkali proof, as a priming coat on such walls. This brings us face to face with the original desire and absolute need for damp proofing and proper coating made by proper people, or, in other words, a damp proofing that does the work.

To my mind, a colorless waxy mixture of an anhydrous nature that can be used in warm weather, or a resinous liquid that can be applied in cold weather or at any time of the year, would be practically the proper coating for buildings constructed of cement blocks, or built in the usual way by throwing concrete in the box forms.

It is well known to all cement users that building a retaining wall is done in layers, and when the lower layer is dry the succeeding layer finished next day, or because of delays at some later period, such layers do not bond, hence the building is arranged with chamfers on the top layer or at the ends of the construction to be followed later by similar work, forming by means of the chamfers a "key," but moisture, particularly on retaining walls with earth embankment on one side, permits a flow of water at such lines of demarkation in the construction of each layer.

For this purpose I would suggest a liquid applied on the dry layer before additional construction is made or attached thereto—a liquid that will bond the two surfaces, immune to the influence of alkali and moisture, so that, in spite of the weight of heavy concrete on a previously finished layer, it would be just as good as if there were a natural "bond." This material is black and a hydro-carbon compound, therefore should not be extended to the extreme edge of concrete retaining wall construction in order to prevent a black line showing. It can be brushed on up to one inch of surface and will answer every purpose.

Right here your careful consideration could be given to the fact that because a black article of a hydro-carbon nature that dries elastic and retains its homogeneous qualities, a purchaser should not be misled by tar and asphalt mixtures, which can be mixed up at a very low price and sold at 10 or 20 per cent less than a reliable article by claiming to be just as good. Some builders in Chicago, and some professionals connected with buildings in this section, have been so badly deceived by imitations of what they knew were good that it eventually led to their clients "holding the bag" and paying for something that was absolutely worthless at any price, even though applied a number of times.

If you will stop to consider, damp proofing is absolutely the smallest cost or a percentage of cost on superstructure walls and masonry of a building, hence can you afford to risk taking an imitation of moisture through the cement walls, in spite of the furring high price, and practically carry your own insurance against dampness? This would be very much like a person of moderate means carrying his own insurance against fire damage to a building.

At Lake Forest, Ill., a town of very fine suburban residences, a building was recently erected entirely of cement. After a conversation with the architect, he was very much afraid that the penetration of moisture through the cement walls, in spite of the furring strips covered with metal lath and plaster thereon, thereby forming an air space, would be creative of a great degree of dampness in the building. Under these circumstances the wooden furring strips would rot away and the expanded metal would be

so thoroughly corroded in the course of several years that the plastering would fall away from the walls. The architect, therefore, ordered such furring strips as had been nailed on the cement should be pulled away and a thoroughly good coating of a black hydro-carbon paint be applied; where the voids were so great that the brush would not fill in or reach, such spaces were troweled to a smooth finish with cement by the contractor. After some weeks of rain, the building having been covered in, he examined the walls very closely and found no moisture could penetrate the interior.

In my estimation, too much stress can not be laid upon this particular point, viz., that all basements and cellars of buildings used for any purpose, particularly as a residence, should be absolutely damp proof and waterproof. You also know that wherever there is darkness there is dampness, and such lower levels of buildings, even when lighted with windows, do not have sunlight to dry up moisture or are entirely dark, hence the moisture and damp conditions are creative of disease germs, and if you will stop to think of the great mortality in every section of the United States, whether of a hilly or mountainous nature, or on the level plains, dry or swampy, typhoid fever has a permanent but very unwelcome home. A man who spends $3,000 or $5,000 for a home looks for everything he can secure in the way of comforts for home and absolutely shuts his eyes to these facts regarding his basement. The man who builds a home at higher cost or because of his wealth can afford a very rich home, is subject to the same influence, and in many cases the architect, following the designs to make a perfect building, is obliged to cut out some items in cost, and such as are absolutely necessary essentials for the protection of health in this particular are the first to be cut out.

In addition, conscientious designers of buildings are approached by persons who claim to have "just as good" a damp proofing as the one perfect article that has given years of satisfaction, and the contractor, not looking into relative merits, will permit substitution of a worthless character, not so much to deceive the owner and architect, but because he is deceived himself by worthless representations or by photographic cuts of

buildings where these things had been used and failed, which later fact he had no opportunity of learning except by reference to the representative of a good article. To sum up the whole question of damp proofing, we should first consider the foundations, which should be thoroughly damp proofed at the footing space by using a damp course connected up on the outside of a building and bonded in courses up to grade or above the water line. This damp course should also be connected with a damp proofing on the floor level, weighted down with sufficient concrete or brick flooring of a weight to withstand hydrostatic pressure. In Chicago there is no tide, hence the cost is usually very much less than would be required for Boston or New York and other coast cities on the Atlantic, as well as at Seattle, Tacoma, San Francisco, and other cities on the Pacific coast with a penetrating, salt atmosphere, or where there may be a tide at cities somewhat inland from the coast.

The use of an elastic hydrating coating on the inside of exposed brick walls, plastering directly on brick walls over such coating on millions of dollars worth of buildings in the past thirty years, and I do not know of any one place where the plastering became loose on such vertical walls, or permitted moisture to penetrate where the material was properly applied. Before going further, it is proper to call attention that a damp course in the foundation does not entirely answer the purpose, for another damp course should be used at the grade line of buildings, so that water splashing about the space of the datum line by capillarity can not penetrate Bedford stone trim or the brick structural wall, resulting in a dirty, black, damp surface during the life of such building. In the use of felt of about three layers for this purpose, as well as for damp proofing foundations before mentioned, do not lose sight of the fact that the several layers of felt should be considered as creating a thickness of damp proof or damp course, and should have no other relation with a proper damp proofing that will retain its homogenous quality, that will not crack by drying out, or the influence of frosty weather.

For the roof side of parapet walls, which usually absorb and attract moisture by capillarity to the roof beams in spite of flash-

ing that the roofer applies on the parapet walls, hence in the place of pitch and tar, which crack and disintegrate and fall off of their own weight, use a cement paint. Thoroughly slush one or two coats on roof side of parapet walls mentioned and on top of the coping. This will also make the cement joints of the coping more thoroughly waterproof.

A cement base paint which dries out the color of cement, therefore, becomes attractive to the consideration of owners of a cement building as a thorough coating on the outside to damp proof by such application; it also gives a uniform cement color not usually obtained, as a dryer day or colder one or a slight change in the mixture of concrete, however careful the builder may be, shows a varying color throughout the building. This material thoroughly brushed in the course of a few weeks would not appear other than as a part of the cement itself.

A cement, for the reason before mentioned of trouble with linseed oil on brick walls, should be used on the outside of walls as a priming coat, followed by two coats of such paint color or finish as desired, and will prevent lime salts in the brick and mortar affecting the paint; for this reason such poor results are obtained by painting cement buildings with ordinary paint.

Bedford stone, marble or any absorbent stone should be backed up on all five sides with a black hydrocarbon paint to within one inch of the face, as being very far superior to the use of any of the so-called non-staining cements, as sufficient moisure penetrating the stone will certainly go through the mortar, and stain can be carried from the back to the face of stone in drying out.

Without saying much more, the question of protecting metal by bedding in concrete has been good in some cases, and where parties have referred to several buildings as an evidence that cement would do this, it does not hold good in over 90 per cent of cases where there is much moisture in the atmosphere or where waterproofing is imperfect; the grillage would eventually be eaten up and such corrosion would be hastened by the lime water of concrete construction. Red lead and other linseed oil paints will not protect structural steel, but a cement paint covered with a hydrocarbon somewhat similar to what was before

mentioned to waterproof, will do the work. Galvanizing is merely a plating and usually imperfect. Moisture penetrates pin holes in this coating; for anchors galanizing is imperfect for this reason, as well as cracking in bending, hence it is better to dip anchors in an elastic coating to prevent corrosion and to prevent the iron oxidizing, which prevents the oxide stain penetrating the face of stone trim.

Referring to the use of several layers of felt with damp proofing liquid, between such layers, mention was made that too much could not be expected of the felt used for the purpose of getting sufficient thickness of coating. My observation of waterproofing has been that the felt has really been the absolute waterproofing and the hot pitch or hot asphalt or whatever name has been used to stick the felt together, when the felt would disintegrate the waterproofing became defective. The coal tar pitch is very brittle when dry, and if even more than 8 per cent of asphalt it is used, it is equally brittle. There is no doubt that the very best protection for walls, whether above or below the ground, is a perfect waterproofing applied as a coating or layer. Mention has been made of an oily or grease base and of a metallic paint, which can not possibly waterproof, even if it should show damp proofing for a limited period.

A good waterproofing for foundation work for each layer, including felt, will cost $4.00 per 100 square feet, or a little less. Such quality of damp proofing has not a ghost of a show of being specified against the very low price of five layers of felt with hot pitch between. The hot pitch sets at once, but as stated, will not be permanent. The felt is the medium to hold for a while. Everybody connected with the business or having had some experience with waterproofing knows well that a sample of tarred felt becomes hard and brittle. I might recommend where there is a tide pressure and a temporary sum is required so that pumping will keep a section dry during the process of waterproofing, it is advisable to use two layers of hard felt with the hot pitch, followed with three layers of an elastic hydrocarbon, so that when the pitch eventually disintegrates the elastic hydrocarbon holds the layers sufficiently adhesive that water will never penetrate.

In Europe, during a period of about forty years, a waterproofing material has been in use to prevent the disintegration of stone, brick and cement surfaces on public buildings. This comes in the form of crystals and is dissolved in water, being applied so that the stone or other surface will absorb the liquid. It has an influence on the molecular constituents of mortar joints as well, overcoming efflorescence and hardening surfaces so that they become eventually waterproof. This material is worth $1.00 per pound and covers from 100 to 200 square feet when dissolved in water, according to the absorption of the surface on which it is applied. It is entirely different from usual coatings, as it hardens with time and continues the hardening process where nature stops. Usual coatings, on the contrary, go back or disintegrate in time and weaken in their influence.

DISCUSSION.

Mr. A. N. Pierson.—A concrete mixed with sufficient water and thoroughly dense, I think, is the secret of waterproofing.

Mr. Horn.—I am very much interested in the subject of waterproofing, and have given it considerable time and attention, as perhaps the best part of my time for the last twelve years has been devoted to that subject.

I heard the statement the previous speaker made that water is the thing to waterproof concrete. I knew nothing about concrete blocks until two years ago, when I was invited to attend the Indianapolis convention, but I know something about the waterproofing of the big structures we have heard so much about in New York, and I had occasion to examine those buildings, having been called in when dampness had penetrated through 12 to 22 inches of masonry, and consequently know that waterproofing is absolutely necessary.

There are several things to be taken into consideration in waterproofing, and they are these: namely, to begin with, as a previous speaker pointed out, it is absolutely necessary to waterproof the substructure; it is immaterial to me as to the materials you use, you are the best judges as to whether your material will be good, bad or indifferent. It is your business to investigate every material on the market, and with very little time and attention you can demonstrate to your own satisfaction whether or not this, that or the other material is good, bad or indifferent.

I am merely going to take up the question of method, and I am going to explain to you, or try to explain to you, that you shall do certain things.

To begin with, Mr. DeKnight pointed out to you that it was necessary to waterproof the substructure, and that it is necessary to put that waterproofing on the exterior of the wall. It is immaterial what waterproofing you use. No waterproofing known has any tensile strength; none will help to resist the pressure. The pressure of water can only be resisted by a counterweight

like concrete or brick masonry. So that it is absolutely necessary to put your waterproofing film—whatever it may be—on the exterior of the wall or if your excavation will not permit your putting that excavation course on the exterior of the wall, build up a four-inch brick curtain wall. After having put your waterproofing against this concrete wall, build up the house wall, thus getting the benefit of the resistance that the house wall affords.

The first essential thing to do is to waterproof over the footing. Put the damp course, as I said, whatever it may be, over the footing, allowing it to protrude on both sides, six to twelve inches, so that you can properly connect the damp course with the real face of the wall. Then put the waterproofing on the exterior and connect it with the waterproofing over the footings, because continuity is essential. If there is any one point at which that film becomes broken, all the money spent is useless, because the water will come in at that one particular point, and almost nothing you can do will help it. So you see the necessity of properly binding the damp course on the outer wall with that over the footings. If you do it in the manner described by me, you have left, also, a connection or lap on the left side of the footing, so that you can connect with the damp course over the cellar floor.

The waterproofing job should be an angle, beginning at the grade level down the outside of the wall, over the footing between two beds of concrete, over the floor, and up on the other side—a complete waterproof box protected by the earth or the curtain wall on the outside, the house wall on the inside, and protected by the top bed of concrete on the floor. If you do it in that manner, you are absolutely certain to obtain a waterproof substructure.

As Mr. DeKnight pointed out, no set specifications can be used. There are various conditions all over the country which you have to meet. If you have a hydrostatic pressure to contend with, it is necessary to determine that pressure and get your counterweight equal to that pressure. For instance, in New York, where we have the pressure of tide water to contend with, we have often as much 8 or 10 or 15 fet of water against which

six inches of concrete is not going to be sufficient. You must calculate the amount of that pressure and put on sufficient concrete for your waterproofing course to counteract the pressure. So it is advisable for engineers contractors, manufacturers of blocks, builders of homes, to consult with a waterproof specialist, of whom there are many, tell him exactly the conditions, and he will devise gladly the method that you shall use for that substructure.

Now, I will come out of the cellar and go to the other part of the building.

To begin with, the term capillarity is very often misused. I am going to give you a simple illustration to show you what I believe capillarity is. It is a mysterious force and it never travels horizontally. It always travels vertically. Take a piece of lump sugar in the morning and put it on top of your coffee and you will find that the dampness is traveling upward. Water will travel by capillarity to the height of about seven feet—never more.

The force is never great enough to bring it up any higher than that one point, so that the dampness in the superstructure that you have to contend with is caused by only two things—rain and condensation. A beating rainstorm with a wind pressure will cause the moisture absorbed by the surface of the wall to penetrate the wall, whether it be 10, 12 or 20 inches thick. It is only a question of how much pressure and how much water you have on the wall. And your second cause for dampness is condensation.

So few people understand insulation. The refrigerating engineer, when he constructs his building, has for his principal object the exclusion of heat. He insulates against the entrance of heat by waterproofing against its source. A wall, when wet, will conduct heat readily, consequently, after he has waterproofed against the source of heat, he builds up air spaces on the interior of the wall, because dead air, confined air, non-circulating air, is the only practically absolute insulator that we have.

I lay stress on the term dead and confined air. I have seen it advocated by concrete block machine manufacturers, and I do not want to be misunderstood here—I have seen it stated by

concrete block machine manufacturers that the continuous air space is the proper method for insulating a building. If that is so, why, with the millions of dollars that are being spent in the country year after year in the erection of cold storage warehouses, and ice manufacturing companies, does the refrigerating engineer confine his air space and make it absolutely dead? So as to prevent circulation. I would like very much to have the gentleman who puts so much faith in the claim of the continuous air space, answer me, and tell me why the refrigerating engineer, who is a specialist along these lines, who has worked his entire lifetime probably on the study of the question of insulation, does the exact contrary to what the concrete block machine manufacturer advocates.

Now, you see the refrigerating engineer is waterproofing toward the source of the heat, not because he is afraid of water bringing in heat, but simply because the water wets the wall, which will thus conduct heat. Consequently, he places his air space on the inside, and thus prevents the heat from coming in or going out, either way you wish to look at it.

But, in ordinary building constructions, you have just the reverse condition. In the winter you wish to consume just as little coal as is possible to keep your building warm, and in the summer time you want to keep as much of the heat out as you possibly can, so as to keep your building cool.

The proper way is to insulate and damp proof your building along the line that the refrigerating engineer does, but not quite so waterproof. Take any good waterproofing and coat the exterior of the wall, thus destroying its porosity and preventing the penetration of water; then coat the inside of your wall with some good waterproofing compound and place the plaster on that. By coating the outside of the wall you keep out the water from the blocks proper, consequently you have a dry block, and concrete is a fairly good insulator if kept dry. It is a physical impossibility to coat a wall with any compound and fill every possible pore, so that in order to make things absolutely certain, coat the inside of your wall with the waterproofing compound, thus decreasing the possibility of water coming through, due to the wall not being properly coated. Between the two coatings

you are confining dead air, which, as I have pointed out, is the best known insulator you can get. Put your plaster up against this coating and get the resistance which that plaster coat forms, the same as you would in your substructure. Now, if you get any wind pressure, the air between the two coats is like a cushion, and will resist that pressure. If you do that you will have absolutely a dry wall and beating rainstorms will not affect it. You will, also, I believe, have walls free from condensation.

MR. SEAFERT.—I believe that coating the inside of the wall will not always prevent condensation, for I know of a building so coated in which the condensation is so very great that it is possible and necessary to mop up the water. A porous wall will not act in this way.

The method of insulating a building by a confined air space may do for refrigerators but hardly for buildings. I know of cases in Europe in which circulation is secured by building a double wall and connecting this air space with the chimney, and good results are obtained.

You cannot have a dry basement simply because you have it waterproof, since there is enough moisture in the air which will condense on the wall if there is no ventilation. A sealed air chamber is probably an excellent thing, but in a residence I believe circulation necessary.

REPORT OF COMMITTEE ON FIREPROOFING AND INSURANCE.

By Edward T. Cairns, *Chairman.*

The past year has witnessed some interesting progress in the development of fire resistive qualities of concrete. In the hollow block line there have been no actual fires of importance in buildings of this construction, so far as your committee have learned, but several tests have been conducted by various parties, all of which tend to confirm the views expressed in last year's report to the effect that concrete, properly made and applied, is an excellent fire resistive material for certain uses, but has limitations which preclude its being properly classed as absolutely "fireproof." Tests such as have recently been reported in the press by Mr. Somerville, of the Washington building department, and others demonstrate beyond doubt that hollow blocks will surely break apart from unequal expansion of the different sides if subjected to a very serious fire and therefore such blocks are not suitable for "fire walls" or for any part of a building which by reason of its size or contents may develop a fire of high temperature or, particularly, of long duration.

Other experiments involving fire of shorter periods or lower temperature have not developed this weakness and indicate that under conditions of comparatively mild exposure hollow blocks may be reasonably safe. Just how much fire they will stand in point of temperature and time is yet to be determined, and we anticipate will be ascertained in the tests now in progress by the Government laboratory under Mr. Humphrey and the Underwriters laboratories at Chicago. We shall be disappointed if considerable of this data is not produced during the current year.

In the field of reinforced concrete the conflagration at San Francisco furnished numerous examples of very good results in concrete floors. There were thirty-one buildings involved in the fire, having more or less concrete, almost all in the shape of floors, of which those of good design and workmanship (accord-

ing to generally accepted standards) came through with little structural damage. Aside from this San Francisco experience the year has brought little in the way of actual demonstrations of fire resistance of reinforced concrete, and anything further on the subject would necessarily be repetition of our report of a year ago.

Insurance companies are still taking an active interest in the investigation of this subject through various committees they are endeavoring to rate all buildings on their merits and are doubtless progressing as rapidly as the state of the concrete building art will permit. As the use of concrete in all forms increases and experience of engineers and builders improves the quality of work, we believe underwriters will be found ready and anxious to recognize liberally all the progress shown, though for the present it is only reasonable that they should be conservative in their ratings on account of the defects in design, material and workmanship which have been so common in the art up to this time.

We would again suggest the importance of members reporting to this committee all cases of fire in buildings of concrete construction of any type. This field experience is most valuable in solving the various questions involved in fireproof qualities of concrete and we respectfully urge that all members bear this committee's work in mind and see that full details of fires are reported.

REPORT OF COMMITTEE ON LAWS AND ORDINANCES.

By H. C. Henley, *Chairman.*

The construction of buildings of reinforced concrete is a new departure, and this form of construction has made rapid progress, notwithstanding that failures have occurred with sufficient frequency to cause some doubt with the public as to its safety. Investigation, where failure has occurred, has shown that the failure was due to an attempt to cheapen the work or that the work was improperly designed or installed, and that the fault could not be attributed to the material employed.

There is no form of building construction that requires more careful attention in design and execution. Proper ordinances and their strict enforcement will do more than anything else to advance the use of this form of building construction.

We submit an ordinance which has recently been drafted and will be introduced in the Municipal Assembly in the City of St. Louis. This ordinance was arranged with all care by a joint committee composed of Structural Engineers, Architects and Concrete Contractors. The ordinance follows:

Reinforced Concrete.

DEFINITIONS.

1. *Reinforced Concrete* is a concrete in which steel is embeded in such manner that the two act in unison in resisting stresses due to external loading.

2. *Concrete* is an artificial stone resulting from a mixture of Portland cement, water and an aggregate.

3. *Portland Cement* shall be as defined in the Standard Specifications adopted on June 14, 1904, by the American Society for Testing Materials.

4. An aggregate, as herein used, means one or more of the following materials: Sand, broken stone, gravel, hard burned

clay. Aggregates will be divided into two classes, fine aggregates and coarse aggregates. A fine aggregate will include all aggregate passing a No. 8 sieve. A coarse aggregate will include all aggregates passing a 1-inch ring and retained on a No. 8 sieve.

QUALITY OF MATERIALS.

1. *Portland Cement* shall conform to the requirements of the specifications of the American Society for Testing Materials, as adopted June 14, 1904, with all subsequent amendments thereto.

2. *Aggregates.* Fine aggregates should be well graded in size from the finest to at least the size retained on a No. 10 sieve. Coarse aggregates shall also be well graded in size from the finest to at least the size retained by a $^9/_{16}$-inch ring. Fine aggregates may contain not more than five per cent, by weight, of clay, but no other impurities. Coarse aggregates shall contain no impurities.

(*a*) *Sand* shall be equal in quality to the Mississippi River sand.

(*b*) *Broken stone* shall be either limestone, chatts, or granite, or some other stone equal to one of these in the opinion of the Commissioner of Public Buildings.

(*c*) *Gravel* shall be clean and free from all foreign substances.

(*d*) *Hard Burned Clay* shall be made from suitable clay free from sand or silt, burned hard and thoroughly. Absorption of water should not exceed 15 per cent.

Concrete. The solid ingredients of the concrete shall be mixed by volume in one of the following proportions:

(*a*) Not more than 3 parts fine aggregate to one of cement.

(*b*) Not more than 2 parts of fine aggregate and 4 parts of coarse aggregate to 1 of cement; but in all cases the fine aggregate shall be 50 per cent of the coarse aggregate.

Concrete shall have an ultimate strength in compression in twenty-eight days of not less than the following:

Burned clay concrete—1,000 lbs. per square inch.

Steel. Steel shall be medium steel or high elastic limit steel.

All other concrete—2,000 lbs. per square inch.

The physical properties shall conform to the following limits:

	Medium Steel.	*High Elastic Limit Steel.*
Elastic limit	Not less than 30,000	Not less than 50,000
Per cent of elongation . . min. in 8″, E. =	$\frac{1{,}800{,}000}{f - 10{,}000}$	$\frac{1{,}800{,}000}{f - 10{,}000} - 10$
Cold bend without fracture on outer circumference	180 deg. flat	90 deg. to radius = 5 times thickness.
Character of fracture, silky.		Silky or fine granular

f = unit stress in steel at rupture.

Tests shall be made on specimens taken from the finished bar, and certified copies of test reports shall be furnished the Commissioner of Public Buildings at his request.

Bending tests shall be made by pressure.

Finished material shall be free from seams, flaws, cracks, defective edges or other defects, and have a smooth, uniform and workmanlike finish, and shall be free from irregularities of all kinds.

A variation of cross-section in the finished bars of two and one-half per cent or more from the specified sizes shall be cause for rejection.

The net area of cross-section of finished bars shall not be less than ninety-seven per cent (97%) of the specified area.

EXECUTION.

All reinforced concrete work shall be built in accordance with approved detailed working drawings. These drawings shall be submitted to the Commissioner of Public Buildings for approval and no work shall be commenced until the drawings shall have been approved by him.

The steel used for reinforcing concrete shall have no paint upon it, but shall present only a clean or slightly rusted surface

to the concrete. All dirt, mud and other foreign matter shall be removed.

If the steel has more than a thin film of rust upon its surface it shall be cleaned before placing in the work.

In proportioning materials for concrete, one bag containing not less than ninety-three pounds of cement, shall be considered one cubic foot.

The ingredients of the concrete shall be so thoroughly mixed that the cement shall be uniformly distributed throughout the mass and that the resulting concrete shall be homogeneous.

The concrete shall be mixed as wet as possible without causing a separation of the cement from the mixture and shall be deposited in the work in such manner as not to cause the separation of mortar from coarse aggregate.

Concrete shall be placed in the forms as soon as practicable after mixing, and in no case shall concrete be used if more than one hour has elapsed since the addition of its water. It shall be deposited in horizontal layers not exceeding eight inches in thickness and thoroughly tamped with tampers of such form and material as the circumstances require.

The steel shall be accurately placed in the forms and secured against disturbance while the concrete is being placed and tamped, and every precaution shall be taken to insure that the steel occupied exactly the position in the finished work as shown on the drawing.

Before the placing of concrete is suspended the joint to be formed shall be in such place and shall be made in such manner as will not injure the strength of the completed structure.

Whenever fresh concrete joins concrete that has set, the surface of the old concrete shall be roughed, cleaned and thoroughly slushed with a grout of neat cement and water.

No work shall be done in freezing weather, except when the influence of frost is entirely excluded.

Until sufficient hardening of the concrete has occurred, the structural parts shall be protected against the effects of freezing, as well as against vibrations and loads.

When the concrete is exposed to a hot or dry atmosphere special precautions shall be taken to prevent premature drying

by keeping it moist for a period of at least twenty-four hours after it has taken its initial set. This shall be done by a covering of wet sand, cinders, burlap or by continuous sprinkling or by some other method equally effective in the opinion of the Commissioner of Public Buildings.

If during the hardening period the temperature is continually above 70° F., the side forms of concrete beams and the forms of floor slabs up to spans of eight feet shall not be removed before four days. The remaining forms and supports not before ten days from the completion of tamping.

If during the hardening period the temperature falls below 70° F., the side forms of concrete beams and the forms of floor slabs up to spans of eight feet shall not be removed before seven days; the remaining forms and the supports not before fourteen days from the completion of the tamping. But if, during the hardening period, the temperature falls below 35° F., the time for hardening shall be extended by the time during which the temperature was below 35° F.

Forms for concrete shall be substantial and must preserve their accurate shape until the concrete has set, and shall be sufficiently tight so as not to permit any part of the concrete to leak out through cracks or holes.

Before placing the concrete, the inside of the forms shall be thoroughly cleaned of all dirt and rubbish; the forms of all beams, girders and columns being constructed with a temporary opening in the bottom for this purpose.

If loading tests are considered necessary by the Commissioner of Public Buildings, they shall be made in accordance with his instructions, but the stresses induced in all parts of a structural member by its test load shall be the same as if the member were subjected to twice the dead load plus twice the assumed live load.

The minimum covering of concrete over any portion of the reinforced steel shall be as follows:

For flat slabs, not less than one inch.

For beams, girders, ribs, etc., not less than one and one-half inches.

For columns, not less than two inches. In computing the strength of columns the outside one inch around the entire column shall be neglected.

For flat slabs continuous over two or more supports and uniformly loaded, the bending moment may be taken as WL, in which W equals total load on the span and L the clear distance between supports.

Beams continuous over supports shall be reinforced to take the full negative bending moment over the supports, but shall be computed as non-continuous beams.

DESIGN.

The weight of burnt clay concrete, including the steel reinforcement, shall be taken at 120 lbs. per cubic foot, unless another weight can be shown.

The weight of all other concrete, including the reinforcement, shall be taken at 150 lbs. per cubic foot, unless another weight can be shown.

Besides the above in calculating the dead loads, the weights of the different material shall be assumed as given in Table No. 1.

The following table gives the uniformly distributed live loads for which structural members shall be designed·

Table No. 2.

DEAD LOAD. Pounds per Square Foot.	CORRESPONDING LIVE LOAD (Pounds per Square Foot).		
	(1) 70%	(2) 100%	(3) 150%
40 or under	72	103	155
50	65	93	140
60	59	84	126
70	53	76	114
80	48	69	104
90	45	64	96
100	41	56	87
110	37	53	80
120	34	49	74
130	31	44	66
140	29	41	62
150 or over	27	39	59

The live loads on floors for dwellings, apartment houses, dormitories, hospitals and hotels, shall be as given in column (1) of Table No. 2.

For schoolrooms, churches, upper stories of office buildings, theatre galleries, use column (2), Table No. 2.

For ground floors of office buildings, corridors and stairs in public buildings, use column (3), Table No. 2.

For columns the specified uniform live loads per square foot shall be used with a minimum of 20,000 lbs. per column.

For columns carrying more than five floors, the live loads may be reduced as follows:

For columns supporting the roof and top floor, no reduction.

For columns supporting each succeeding floor, a reduction of 5 per cent. of the total live load may be made until 50 per cent is reached, which reduced load shall be used for the columns supporting the remaining floors.

This reduction is not to apply to live load on columns of warehouses, and similar buildings which are likely to be fully loaded on all floors at the same time.

The method used in computing the stresses shall be such that the resultant stresses shall not exceed the prescribed unit stresses as computed on the following assumption:

(1) That a plane section normal to the neutral axis remains such during flexure, from which it follows that the deformation in any fibre is directly proportionate to the distance of that fibre from the neutral axis.

(2) That the modulus of elasticity remains constant within the limits of the working stresses fixed in these regulations, and is as follows:

Steel, 30,000,000 lbs. per square inch.

Burnt clay concrete, 1,500,000 lbs. per square inch.

All other concrete, 2,000,000 lbs. per square inch.

(3) That concrete does not take tension, except that in floor slabs, secondary tension induced by internal shearing stresses may be assumed to exist.

UNIT STRESSES.

The allowable unit stresses under a working load shall not exceed the following:

Burnt clay concrete	Direct compression ....300 lbs. per sq. in. Cross bending ....400 lbs. per sq. in. Direct shearing ....150 lbs. per sq. in. Secondary tension. .... 15 lbs. per sq. in.
All other concretes	Direct compression ....500 lbs. per sq. in. Cross bending ....800 lbs. per sq. in. Direct shearing ....300 lbs. per sq. in. Secondary tension .... 30 lbs. per sq. in.

STEEL.

	Medium Steel.	*High Elastic Limit Steel.*
Tension	14,000	20,000

The compression in the steel shall in all cases be computed from the compression in the concrete.

The unsupported length of a column shall not exceed fifteen times its least lateral dimension.

In a column subjected to combined direct compression and flexure, the extreme fibre stress resulting from the combined action shall not exceed the unit stress prescribed for direct compression.

All columns shall have longitudinal steel members so arranged as to make the column capable of resisting flexure, and these longitudinal members shall be stayed against buckling at points whose distance apart does not exceed twenty times the least lateral dimension of the longitudinal member. In no case shall the combined area of cross-section of these longitudinal members be less than one per cent of the area of the concrete used in proportioning the column, and the stays shall have a minimum cross section of three one-hundredths of a square inch (0.03 sq. in.).

If a concrete column is hooped with steel near its outer surface either in the shape of circular hoops or of a helical cylinder and if the minimum distance apart of the hoops or the pitch of the helix does not exceed one-tenth the diameter of the column, then the strength of such a column may be assumed to be the sum of the following three elements:

1. The compressive resistance of the concrete when stressed not to exceed 1,000 lbs. per square inch.

2. The compressive resistance of the longitudinal steel reinforcement when stress corresponds to working stress in concrete.

3. The compressive resistance which would have been produced by imaginary longitudinals stressed the same as the actual longitudinals; the volume of the imaginary longitudinals being taken at two and four-tenths (2.4) times the volume of the hooping. In computing the volume of the hooping it shall be assumed that the section of the hooping throughout is the same as its least section. If the hooping is spliced the splice shall develop the full strength of the least section of the hooping.

The minimum distance, center to center, of reinforcing steel members shall not be less than twice the maximum diameter or diagonal dimension of cross sections plus one inch.

CONCRETE BLOCKS.

1. These regulations shall apply to all structural material known as concrete blocks, manufactured from Portland cement, manufactured in accordance with the standard specifications for Portland cement adopted by the American Society of Testing Materials, and certain additions of sand, crushed stone, gravel or other approved aggregate.

2. Before any such concrete blocks may be used in construction of any building, an application for such use must be filed with the Commissioner of Public Buildings, embodying a brief outline of the process of manufacture and specifications as to the character and proportions of the material used, and samples of the finished blocks proposed to be used shall be selected under the direction of the Commissioner of Public Buildings for the purpose of subjecting same to tests in the following particulars:

(*a*) Ultimate compressive strength, at the end of 28 days, shall not be less than 800 pounds per square inch.

(*b*) The absorption shall not exceed 15 per cent at the end of twenty-four hours.

(*c*) The modulus of rupture shall not exceed 150.

(*d*) A freezing and fire test to determine whether the material will withstand ordinary usage.

Any expense attending such test shall be paid by the applicant.

3. Concrete building blocks may be used for buildings three stories or less in height only after said use has been duly approved by the Commissioner of Public Buildings. Concrete blocks, in order to be accepted for test by the Commissioner of Public Buildings, shall be composed of at least one part of Portland cement, three parts coarse, sharp sand and not to exceed five part of approved aggregate.

4. All materials entering into the composition of hollow concrete blocks shall be of such fineness as to pass ½" ring and be free from extraneous matter. The hollow space within such blocks shall not exceed the percentage given in the following table for different heighths of walls, and in no case shall the walls or ribs of the blocks be less in thickness than one-fourth of the height:

Stories.......	1	2	3
1, 2 and 3...	33	33	25

5. Thickness of walls, for any building, where hollow concrete blocks are used, shall not be less than are required by law for brick walls.

6. Where the face only is of hollow concrete blocks, and the backing is of brick, the facing of hollow concrete blocks must be thoroughly and strongly bonded to the brick, either with headers projecting four inches into the brick course, every fourth course being a header course, or with approved ties. No brick backing to be less than nine inches. Where the walls are made entirely of concrte blocks and where said blocks have not the same width as the wall, every fifth course shall extend through the wall, forming a secure bond. All walls where concrete blocks are used shall be laid in Portland cement mortar.

7. All hollow concrete building blocks must have attained the age of at least thirty days before being used.

8. The supports for girders or beams intended to carry a concentrated load of over two tons shall in all cases be composed of piers constructed of concrete blocks made solid, and said piers must be of the dimensions required by this ordinance for brick piers.

9. Concrete lintels in walls shall be reinforced with steel rods in a manner satisfactory to the Commissioner of Public Buildings, and any lintel extending over four feet six inches in the clear shall rest on solid concrete blocks.

NOTES ON THE INVESTIGATION OF CEMENT MORTARS AND CONCRETES IN THE UNITED STATES GEOLOGICAL SURVEY LABORATORIES AT ST. LOUIS, MISSOURI.

By Richard L. Humphrey, M.Am.Soc.C.E.*

This and other associations have heard a great deal about St. Louis and what we are going to do, so what I am about to say may not be entirely new to you.

The work at St. Louis, as you know, was organized some two years ago, and the very limited appropriation available was insufficient for doing anything more than getting a start, and it was not until June of the past year that an appropriation of $100,000 was made for the investigation of structural materials, and by vote of the various people who have acted in an advisory capacity on the expenditure of this money, it was decided that it should be expended for investigations of cement mortars and concretes. Naturally, that is an extensive field, and it was difficult to tell just what phases of it should be taken up first.

The National Association of Cement Users signified early that they would like to have a series of tests of concrete blocks, and we are carrying on an extensive investigation of that material. Then the materials, such as sand, gravel and crushed stone, are being collected from all over the country, and investigations are being made as to the strength of various proportions of those materials. These include fine sands, sands charged with clay, and other materials, such as you have been discussing here for the last two or three days. A great deal of work has already been done, but by far the greater portion has not been started, owing to the lateness with which a sufficient appropriation was made.

The investigation of beams is perhaps the most elaborate that has ever been undertaken, and there are in the persent series some six hundred beams, which is larger than the combined number of all beams that have been made in this country up to the

*Consulting Engineer, Philadelphia, Pa.

present time. The beams are all 13 feet long and 8 inches by 11 inches in section.

The present tests can be divided into three series, as follows:

1. A series of 144 beams of four aggregates, cinders, limestone, granite and gravel, and three consistencies, wet, medium and dry.

2. A series of 336 reinforced beams of four aggregates, cinders, limestones, granite and gravel, in which the percentage of reinforcement varies from about ½ to 2 per cent. The reinforcing bars are ½ inch round steel.

3. A series of 96 reinforced beams of limestone, in which the size of the rods is varied.

Before these series are completed others which are now being planned will be started, so that in a short time we should know considerably more about reinforced concrete than we do now.

In the concrete block laboratory we have some six machines, which typify the various machines on the market, such as the two-piece block, single and double air space block, the down faced block, the wet process block, that is, the sand molded block, and so on.

Those blocks are all made with the same sand, with different proportions and consistencies. The blocks are stored in damp chambers and are tested for their physical strength, and also shipped to Chicago, where they are being tested in the furnace at the Underwriters' Laboratory for their fire-resisting qualities.

The force at St. Louis consists of about forty men, which will be materially added to this year, and there is every reason to believe that the information will come at regular intervals. When the series of tests on blocks is completed, the value of blocks made under different conditions of different materials will be pretty well established. Certainly, some of the strength values that are needed in the drafting of an ordinance will be obtained, such as the compressive strength the block ought to have at a given period, what the modulus of rupture should be, and what the absorption should be. We will also be able to tell you more about the process of steam curing, how a block should be cured in steam in order to develop its qualities in a very short time.

I have hoped that we would be able to tell you this at this convention, but the work has not advanced far enough to give you an authoritative statement, and I do not believe in giving you information that may be misleading, or have to be subsequently revised. You certainly will receive at the next convention, barring the unexpected, information of value to you.

The work is thoroughly organized. We have competent men, but we must first educate them in the art of making a good block before the results obtained can be of any value. The question of the relative value of the different sands and different proportions and methods of handling; whether it is best to sprinkle a block out in the open air, submerge it in water, or cure it in the steam chamber, are all of vital importance to you, and we are going to exhaust the subject so as to give you the information.

I do not know that I should dwell on this matter at length, but we have prepared a program which was sent out to the various cement machinery associations and others, showing the scope of the investigations of blocks, of which I will briefly outline to you some of the phases. For instance, we have the type of wall block, all plain face with standard ends, and with and without facing. With facing, we have the one-piece block, hollow block, down face, with single and double air space; side face with double and single air space; solid block, down face and side face; two-piece wall block, with metallic bond and without metallic bond.

The information obtained when the work outlined in this program is completed ought at least throw some light on the subject of how to make a good block.

I did not expect at this time to give you very elaborate information, but simply to give you some idea of the progress, and my paper is therefore called "Notes on Investigation of Cement Mortars and Concretes." I wish to assure you that should I be able to appear before you at the next convention I expect to be in a position to give you the results of work we have done, and I wish to say there are no more elaborate tests than these which have been undertaken by the United States Government.

CHAIRMAN LARNED.—You have heard Mr. Humphrey's general remarks. They certainly suggest to this Association that

within a very short period we are going to have some very valuable information. I believe that in order that this matter might be encouraged the Association should take some action in regard to urging Congress to make a liberal appropriation. It is expensive work, and takes a large force. It cannot be done in a short time. I think our influence in the last session, in petitioning Congress through our individual Congressmen, had its weight, and while I do not know that such action is recommended at this time, it occurs to me it might be a very good thing to do.

REGISTER OF THOSE IN ATTENDANCE, THIRD CONVENTION.

Richard L. Humphrey, Philadelphia, Pa.
Merrill Watson, New York.
O. U. Miracle, Minneapolis, Minn.
A. Monsted, Milwaukee, Wis.
W. W. Curtis, Chicago, Ill.
H. C. Turner, New York.
M. S. Daniels, Suffern, N. Y.
George L. Stanley, Ashtabula, Ohio.
T. L. Condron, Chicago, Ill.
Charles D. Watson, Toronto, Can.
E. S. Larned, Boston, Mass.
J. F. Angell, Columbus, Ohio.
H. C. Henley, St. Louis, Mo.
Universal Portland Cement Company, Chicago, Ill.
    B. F. Affleck, B. H. Rader.
M. Bovee & Son, Northville, Mich.
    M. Bovee, H. A. Bovee.
Peerless Brick Machine Company, Minneapolis, Minn.
    L. V. Thayer, P. Murphy, J. A. Goodwin, J. T. Shedd.
Runyon Concrete Machine Company, Cleveland, Ohio.
    C. M. Runyon.
Technical Publishing Company, Cleveland, Ohio.
    A. M. Ferry, A. E. Warner.
Cement & Engineering News, Chicago, Ill.
    William Seafert.
Cement Brick Company, Port Huron, Mich.
    D. McArron.
F. Wyatt, Rochester, N. Y.
Sandusky Portland Company, Sandusky, Ohio.
    R. R. Fish.
Altoona Concrete Construction & Supply Company, Altoona, Pa.
    Frank Brandt.

Chrisman Concrete Stone Company, Chrisman, Ill.
W. A. Jones.
W. H. Beiser Brothers, Alton, Ill.
W. C. Beiser.
A. J. Cromer, Brandford, Ont.
Capital City Concrete Company, Springfield, Ill.
P. E. Taintor.
E. C. Mack, Alton, Ill.
George H. Gill, Surprise, Neb.
Phil Schaller, Sac City, Iowa.
Miller Lumber Company, Appleton, Wis.
G. M. Miller.
Honroe J. Jaxon, Chicago, Ill.
Simpson Cement Mold Company, Columbus, Ohio.
B. L. Simpson.
Concrete Publishing Company, Detroit, Mich.
E. R. Kranich, W. C. Boynton, E. B. Wolfrom, R. Marshall, J. H. Twitchell.
Cement Machinery Company, Jackson, Mich.
Sid L. Wiltse, Charles Dixon, W. H. McDowell, Eugene McDowell, Wheeler McDowell, J. W. Boardman, Jr., W. F. Cowham, John Miller.
Dykema Company, Grand Rapids, Mich.
F. L. Dykema, George O. Adams.
W. J. Genthner, Despatch, N. Y.
Mrs. W. J. Genthner.
McCarrel Composition Stone Company, Jacksonville, Fla.
Robert McCarrel.
Northwestern Steel & Iron Works, Eau Claire, Wis.
John H. Holn, Alexander Emery.
American Hydraulic Stone Company, Denver, Col.
H. H. Rice.
Beloit Concrete Stone Company, Beloit, Wis.
W. J. Scoutt.
National Hydraulic Stone Company, Baltimore, Md.
D. A. Leonard, John H. Adams, W. B. Appleby.
Miracle Pressed Stone Company, Minneapolis, Minn.
R. O. Miracle.

Two Miracle Concrete Company, Helena, Mont.
Fisher Hydraulic Stone & Manufacturing Co., Baltimore, Md.
W. H. Fisher, A. N. Pierson, F. M. Scott, D. A. Leonard, John P. Bullington, C. T. Massey, F. McMillen, B. Grau, William Manning.
Steve Wright, Memphis, Tenn.
George B. Elliott.
W. H. Phillips, Columbus, Ohio.
Cement Era, Chicago, Ill.
J. E. Montgomery, W. W. Mickelberry, E. C. Schmidt, G. C. Weed, E. H. Baumgartner, R. Rodine, J. Jones.
Hotchkiss Concrete Stone Company, Chicago, Ill.
William S. Hotchkiss.
G. F. Lillie, Tekamah, Neb.
Hamlin Sons, Lake Villa, Ill.
Benjamin Hamlin, Charles B. Hamlin, Fred T. Hamlin, Frank M. Hamlin.
The Concrete Age, Atlanta, Ga.
George C. Walters.
Hartwick Machinery Company, Jackson, Mich.
I. W. Hartwick.
A. B. Kelley, Jackson, Mich.
George D. Schreffler, E. C. Gross.
F. L. Davidson, Chelsea, Mich.
Central Concrete Construction Company, Louisville, Ky.
Robert C. Morris, President; P. S. Hudson, T. V. Brown.
Harding & Woodfolk, Scottville, Ill.
Richard B. Sears, Editor *Cement,* New York, N. Y.
F. C. Boyer, Frank Sears.
Municipal Engineering & Contracting Company, Chicago, Ill.
T. F. Meek, C. E. Bathrick, A. M. Broughton, T. M. Mills.
Nodamp Concrete Block Manufacturing Co., Minneapolis, Minn.
F. W. Tidball, Milwaukee, Wis.
John Miller, C. E. Brewster.
Lehigh Portland Cement Company, Allentown, Pa.
Col. C. H. Trexler, C. F. O'Neil, Fred. E. Paulson, B. L. Swett, C. M. Foster.
H. L. Bailey, Chicago, Ill.

The Standard Machine Company, Kent, Ohio.
F. A. Kershaw, E. N. Barber, A. L. Post.
H. C. Miller & Co., New York, N. Y.
H. C. Miller.
A. C. Horn, New York, N. Y.
Clinton Wire Cloth Company, New York, N. Y.
Albert Oliver.
A. Ellefson, Fort Smith, Ark.
Howard G. Goodwin, Akron, Ohio.
American Cement Roofing Company, Columbus, Ohio.
J. E. Hicks, Charles Spenny, August Glass, Henry Boden.
Sense Brothers, Lafayette, Ind.
H. C. Sense.
Chicago Portland Cement Company, Chicago, Ill.
N. D. Fraser, W. F. Main, J. McDaniel.
J. R. Harrington, Edinburg, Ill.
Illinois Gravel Company, Princeton, Ill.
C. S. Scott.
Municipal Engineering Company, Indianapolis, Ind.
C. C. Brown, F. T. Randall.
Wiselogel Company, Muskegon, Mich.
W. F. Wiselogel.
F. M. Ballou Company, Providence, R. I.
F. B. Follett.
William Bell, Elgin, Ill.
Berthelet Construction Company, Milwaukee, Mich.
W. T. Berthelet.
Frahm Concrete Company, Davenport, Ia.
J. B. Frahm.
Queen City Brick Company, Traverse City, Mich.
W. J. Hobbs.
New Castle Stone Company, New Castle, Pa.
W. P. Hanna.
Hot Springs Construction Company, Hot Springs, Ark.
C. E. Marks.
National Builder, Chicago, Ill.
Battjes Fuel & Brick Company, Chicago, Ill.
N. H. Battjes.

L. E. Porter, York, Neb.
F. C. McClannahan, Port Brand, Ind.
Addison Brannin, Aberdeen, Miss.
A. J. Maynard, Bridgewater, Mass.
W. E. Dunn, Chicago, Ill.
Hampden Pressed Stone Company, Springfield, Mass.
T. W. Jennings.
Western Cement Company, Louisville, Ky.
A. L. Kanagy.
Eastern Expanded Metal Company, Boston, Mass.
William M. Bailey.
F. W. Dunn, Chicago, Ill.
Consolidated Litholite Company, Saratoga Springs, N. Y.
D. B. Ledlie.
Simson Brothers Company, Boston, Mass.
H. B. Andrews.
St. Louis Granitoid Curb Company, St. Louis, Mo.
R. Schulz.
J. F. Neubauer, Cedar Rapids, Ia.
Castalia Portland Cement Company, Pittsburg, Pa.
C. L. Johnson.
Newaygo Portland Cement Company, Grand Rapids, Mich.
L. W. Cheney.
C. W. Boynton, Chicago, Ill.
Rock Products, Louisville, Ky.
E. F. Defebaugh, Fred K. Irvine, B. L. McNutty, E. N. Newton, H. B. Warner.
Cement Age, New York, N. Y.
F. F. Lincoln.
The Avery Seale Company, Milwaukee, Wis.
Locke Etheridge.
Kakiat Company, Suffern, N. Y.
W. H. Osborn.
J. W. Penushka, New Orleans, La.
Alex. C. Binnie, Ludlow, Mass.
Adolph Adams, Kendallville, Ind.
C. S. Harris, Sargent, Neb.
E. E. Benner, Lincoln, Neb.

S. T. Henry, *Engineering Record,* New York, N. Y.
W. E. Buser, Mt. Morris, Ill.
W. Worth Bean, Jr., Benton Harbor, Mich.
Art Concrete & Concrete Company, New York, N. Y.
F. J. Mason.
Robert W. Hunt & Co., Chicago, Ill.
J. E. Moore.
Scheutte Concrete Construction Company, Manitowoc, Neb.
Sanford E. Thompson, Newton Highlands, Mass.
E. A. Smith, Broadhead, Wis.
George W. De Smet, Chicago, Ill.
Meacham & Wright Company, Chicago, Ill.
C. Reid.
Ironite Company, Chicago, Ill.
Western Cement Company, Louisville, Ky.
J. M. Rush, Milford, Ill.
H. Rush, Milford, Ill.
Robinson & Stewart, Neponsit, Ill.
A. M. Robinson.
Hill & Van Wagner, Syracuse, N. Y.
J. M. Hill.
August Radtke, Chicago, Ill.
Artificial Stone Manufacturing Co., South Omaha, Neb.
Western Lime & Cement Company, Milwaukee, Wis.
C. Weiler.
Western Builder, Milwaukee, Wis.
N. A. Wigdale.
W. M. Bailey, Boston, Mass.
Concrete Stone Sand Company, Youngstown, Ohio.
A. A. Pauly.
J. R. Gill, Jackson, Miss.
Victory Cement Brick Company, Bayside, N. Y.
J. G. Hamill.
N. W. Expanded Metal Company, Chicago, Ill.
C. F. Dynes.
Sand Munnel, Cannonsburg, Pa.
S. McAdams, Reynolds, Ill.
Fred Fisher, Milwaukee, Wis.

New Way Motor Company, Lansing, Mich.
General Concrete Company, Milwaukee, Wis.
C. H. Bossert.
Western Portland Cement Company, Yankton, S. D.
K. W. Lick, Kenton, O.
M. T. Roche, St. Paul, Minn.
William Ruprecht, St. Louis, Mo.
A. W. Weimer, Geneseo, Ill.
J. L. Haynes, Decherd, Tenn.
Rochester Composite Brick Company, Rochester, N. Y.
R. W. Holden.
C. W. Caldwell, Windsor, Ont., Can.
T. H. Sherman, Brooklyn, N. Y.
A. C. Moffett, Connersville, Ind.
Wettlaufer Bros., Buffalo, N. Y.
J. E. McAvoy, White Hill, Ill.
L. M. Goddard, La Cross, Wis.
Welch-Hawley Company, Urbana, Ill.
C. J. Welch.
Newaygo Portland Cement Company, Grand Rapids, Mich.
Joseph F. Lockley.
Schmidt Concrete Company, Peoria, Ill.
J. P. Schmidt.
N. Underwood, Durham, N. C.
Cleveland Concrete Building Block Company, Cleveland, Ohio.
R. W. Russell.
W. A. Lunesford, Madisonville, Ky.
Modern Concrete Machine Company, Terra Haute, Ind.
D. W. Henry.
Loomis & Ross, Mattoon, Ill.
E. Lind, Moonsocket, S. D.
Medina Concrete Company, Medina, O.
W. I. Kennedy.
T. Shea, Springfield, Mass.
Lykens Concrete Block Manufacturing Company, Lykens, Pa.
J. Myflot, St. Louis, Mo.
C. F. Nesbit, Dixon, Ill.
Seal & Brooking, Pekin, Ill.

C. F. Buente, Pittsburg, Pa.
L. B. Williams, Coon Rapids, Ia.
H. C. Henley, St. Louis, Mo.
Barr & Behymer, Batavia, Ohio.
J. L. H. Barr.
Kansas City Portland Cement Company, Kansas City, Mo.
F. E. Wear.
William Hanner, Beloit, Wis.
M. C. Robinson, Ashtabula, O.
The Flint Stone Company, Toledo, Ohio.
F. K. Hogue.
H. Weiderhold, Philadelphia, Pa.
L. M. Goddard, La Crosse, Wis.
H. A. Sutter, St. Joseph, Mo.
Kankakee Art Company, Kankakee, Ill.
F. F. Martin, Beloit, Wis.
W. N. Sorter, E. Orange, N. J.
National Concrete Company, Bloomington, Ill.
R. Hasenwaikle.
United Cement Manufacturing Company, Columbus, O.
J. F. Angell.
C. H. Issel, Cleveland, O.
R. D. Neale, Lafayette, Ind.
John Downs & Sons, Ft. Madison, Ia
John Downs.
H. T. Boylan, Buchanan, W. Va.
A. L. Bender, Topeka, Kan.
C. R. Phelps, Marion, O.
L. Dickeman, Stilman Valley, Ill.
Balyeat Coal Company, Van Wert, O.
H. C. Otto, St. Louis, Mo.
P. O. Munson, Galesburg, Ill.
F. G. H. Kreamer, Chicago, Ill.
L. M. Hipsher, Marion, Ohio.
Schatzinger Concrete Manufacturing Co., Cleveland, Ohio.
New Rock Machine Company, Delavan, N. Y.
C. Walker & Son, N. Platte, Neb.
C. Walker.

Ricketson Mineral Paint Works, Milwaukee, Wis.
C. F. Bogk.
Driscoll & Gochuauer, Appleton, Wis.
M. K. Gochauer.
Hampton Cement Construction Company, Hampton, Ia.
G. E. Sargent.
H. B. Andrews, Boston, Mass.
L. L. Bingham, Estherville, Iowa.
W. A. Feather, Jr. Baroda, Mich.
Hydraulic Concrete Machine Company, Buffalo, N. Y.
G. F. Fisher.
William Conk, Long Branch City, N. J.
Builders Concrete Company, Cleveland, Ohio.
C. C. Nims.
D. E. Kramer, Pittsburg, Pa.
Simpson Cement Mold Company, Columbus, Ohio.
H. G. Simpson, B. L. Simpson.
Perfection Block Machine Company, Minneapolis, Minn.
M. K. Sawyer, J. T. Summers, B. C. Dow.
American Steel & Wire Company, Chicago, Ill.
H. J. Doyle.
Popular Block Machine Company, Minneapolis, Minn.
George E. Birmingham.
George A. Beck.
A. E. Jones.
Multiplex Machine Company, Toledo, Ohio.
William H. Coalwell, R. E. Teets, George A. Coalwell, L. H. Tschuney.
G. B. Kirwan, St. Louis, Mo.
Joseph Snyder, Kent, Ohio.
D. P. Vining, Niagara Falls, N. Y.
W. J. Brogan, Brooklyn, N. Y.
John Early, Newton, Kan.
M. J. Lyons, La Crosse, Wis.
N. A. Maguissen.
J. T. Evans.
A. Peterson.
A. Aiken.

P. P. Comoli, Sioux City, Iowa.
Sylvania Concrete Company, Sylvania, Ohio.
D. G. Chanler.
W. W. Birnstock, York, Pa.
J. W. Sanderson, Burlington, Iowa.
B. F. Shope, Maxwell, Iowa.
Grant Yon, Altoona, Pa.
Beiser & Bro., Alton, Ill.
Henry Beiser.
C. A. Hoff, Lykens, Pa.
J. S. Kaiff, Chicago, Ill.
G. S. Ormsby Mortar Gauge Company, Xenia, Ohio.
H. M. Ormsby, George S. Ormsby.
L. E. Lawson, Springfield, Ill.
William Perry, Crown Point, Ind.
O. J. Bowen, Harvey, Ill.
Hydraulic Concrete Company, Buffalo, N. Y.
W. W. Wade.
F. H. Meyer, Deshler, Ohio.
Berthelet Concrete Company, Milwaukee, Wis.
J. R. Berthelet, V. E. Berthelet.
St. Louis Construction Company, St. Louis, Mo.
E. Eckard.
Modern Concrete Machine Company, Terre Haute, Ind.
P. A. Bousher.
Hydrex Felt & Engineering Company, New York, N. Y.
Edward W. DeKnight.
Solvent Cement Company, Sullivan, Ind.
C. Mankedick, A. H. Mankedick, W. A. Mankedick.
W. A. Thomas, Louisville, Ky.
E. L. Jones, Chillicothe, Ohio.
William Jordan, Jr., St. Louis, Mo.
Ottumwa Concrete Block Company, Ottumwa, Iowa.
John Fulmer, C. E. Fulmer, Edward Keefe.
H. W. Bedell, Bloomfield, Ont.
Ft. Wayne Concrete Stone Company, Ft. Wayne, Ind.
L. C. Jocquel, C. H. Schulz.
J. Frohm Concrete Company, Davenport, Ia.
J. B. C. Frohm.

D. F. Reichard, Crawfordsville, Ind.
Eli Defnet, Neenah, Wis.
L. M. Goddard, La Crosse, Wis.
H. D. Gerth, Fairmount, Minn.
C. M. Maynard, Scranton, Pa.
Battjes Fence & Brick Machine Company, Grand Rapids, Mich.
    Frank Battjes, Ed. Kilmer.
F. A. Patterson, Fairmont, Minn.
Caldwell Silex Stone Company, Windsor, Ont.
    C. W. Caldwell.
H. C. Otto, St. Louis, Mo.
The St. Joseph Concrete Stone Company, St. Joseph, Mo.
    F. M. Hunter.
Cement Stone & Supply Company, Wichita, Kan.
    J. F. West.
Buser Concrete Construction Company, Mount Morris, Ill.
    Iva D. Buser.
C. W. Walter, Mendota, Ill.
S. C. Snider, Waterloo, Ia.
G. Walter, Mendota, Ill.
G. A. Harrington, Edinburg, Ill.
Robinson & Stewart, Neponset, Ill.
    C. K. Stewart, Roy Swayze.
Hill & Van Wagner, Syracuse, N. Y.
    Albert Van Wagner.
H. S. Hibbard, Boston, Mass.
F. A. Little, Fond Du Lac, Wis.
E. Lind, Woonsocket, S. D.
B. L. Morrow, Waterloo, Ia.
O. H. Bossert, Milwaukee, Wis.
Elyria Plaster Company, Elyria, O.
    G. B. Ashcroft.
Roman Stone Company, Toronto, Can.
    W. S. Griswold.
Western W. Company, Elsah, Ill.
    A. Marshall.
J. W. Cotter, Appleton, Wis.
L. Balyeat, Van Wert, O.

G. M. Baurau, Bloomington, Ill.
J. A. Lane, Stevensville, Mich.
J. Hammond, Geneseo, Ill.
P. F. Connelly, Sioux Falls, Ia.
Bovee Grinder & Furniture Company, Waterloo, Ia.
B. L. Morrow.
J. C. McClennahan, New York, N. Y.
F. H. Miller, Waukegan, Ill.
P. Bozema, Grand Rapids, Mich.
Jake Bozema, Grand Rapids, Mich.
F. Goepper, Indianapolis, Ind.
P. W. Rusterhatch, Chicago, Ill.
G. H. Carlon, Oscaloosa, Ia.
F. J. Lemon, Findlay, Ohio.
F. Bastow, Waukegan, Ill.
W. F. Kelein, Rockfield, Ind.
J. A. Gale, Freeport, Ill.
W. J. Kennedy, Medina, O.
C. R. Warner.
R. W. Russell, Cleveland, Ohio.
John Downs, Ft. Madison, Ia.
B. Schatzinger, Cleveland, O.
S. Westra, Grand Rapids, Mich.
W. G. Adams, Bloomingdale, Mich.
S. W. Wood, Plainville, Kansas.
L. L. Brady, Moulton, Iowa.
G. L. Bradshaw, Indianapolis, Ind.
F. McQuern, Springfield, Ill.
Omaha Concrete Stone Company, Omaha, Neb.
A. F. Bowers, Rochester, Ind.
Fred Gratz, Pendore, Ohio.
P. Petri, Lacon, Ill.
L. H. Tittle, Springfield, O.
H. Tarbox, Findlay, Ohio.
L. H. Allen, Lacon, Ill.
G. L. Bryan, Minneapolis, Minn.
J. W. Pierson, E. Orange, N. J.
W. W. Sawyer, Rockford, Ill.

A. T. Douglass.
M. C. Robinson, Ashtabula, O.
W. O. Banker, Eaton, Ohio.
W. E. Good.
William Runge, Plymouth, Wis.
J. O'Connor, Milwaukee, Wis.
Keuna Bros., Cleveland, Wis.
H. A. Sutter, St. Joseph, Mo.
C. Ohmart, Springfield, Ohio.
W. G. Stockham, Piqua, Ohio.
R. J. Angell, Waukesha, Wis.
F. P. Woodruff, Knoxville, Iowa.
The Leader Sidewalk Company, Wausau, Wis.
    Mr. Oslund.
Harding & Woolfolk, Scottville, Ill.
Charles A. Nutter, Wausau, Wis.
W. H. Butler, Springfield, Ill.
J. Watts, Newton, Ill.
F. B. Thomas, Tampico, Ill.
C. H. Russell, Waverly, Ia.
H. Hagenbush, Winamac, Ind.
Kansas City Portland Cement Company, Kansas City, Mo.
    W. E. Miller.
W. R. Kennedy, Terre Haute, Ind.
H. Birholz, Biroda, Mich.
F. Douglass, Plainfield, Ind.
H. C. Berschen, St. Paul, Minn.
J. H. Miller, Winamac, Ind.
W. L. Blackburn, Hillsboro, Ill.
J. W. Hatch, Rock Falls, Ill.
H. Watts, Knightson, Ind.
Cement Brick Company, Detroit, Mich.
    D. M. Kennedy.
F. B. Hanner, Beloit, Wis.
W. S. Miller, Portland, Ind.
T. M. McKee, Cleveland, O.
Art Portland Cement Company, Kimmell, Ind.
    M. M. Smith.

Haynes Milling Company, Portland, Ind.
E. M. Haynes.
J. P. Berschen, St. Paul, Minn.
A. R. Edmunds, Indianapolis, Ind.
H. B. Hecock, Ellera, Ohio.
R. Smith, Rock Falls, Ind.
A. W. Early, Rock Falls, Ill.
H. Behrens, E. St. Louis, Ill.
Ashland Steel Range & Manufacturing Company, Ashland, O.
D. Nice, U. V. Shelly, Clarence E. Williams, A. B. Lovett, A. J. Bentz, J. A. Levinson, R. T. Satterlee, H. J. Grevison.
Perfection Block Machine Company.
M. K. Sawyer, A. J. Smith.
Charles D. Russell, Minneapolis, Minn.
C. A. Moore, J. M. Schenk, F. T. Pfiffner.
Lehigh Portland Cement Company, Mitchell, Ind.
E. E. Fillion.
Universal Portland Cement Company, Chicago, Ill.
A. E. Robinson, J. L. Nelson, E. A. Coates, H. MacRobert, Jr.
Universal Portland Cement Company, St. Louis, Mo.
J. C. VanDorn, Edward Quebbeman.
Whitehall Portland Cement Company, Philadelphia, Pa.
E. G. Brick, H. F. Ranch, Charles Robinson, H. B. Green.
Stevens Cast Stone Company, Chicago, Ill.
Cement Age, New York, N. Y.
F. F. Lincoln, E. Jennews, M. J. Griffith, G. A. Bockrath, C. W. Tainter, A. T. Kramer.
A. Koppel Company, Chicago, Ill.
O. C. Plessner, P. J. Nash, E. Aldrich, K. Wiggins, A. Stern.
Eureka Machine Company, Jackson, Mich.
James J. Cox.
The X. L. Concrete Stone Company, Kansas City, Mo.
F. S. Phillips, E. E. Evans, E. Anerson.
International Fence & Fireproofing Company, Columbus, O.
J. M. Campbell, R. N. Cunningham, S. M. Randolph.

W. B. Hough Company, Chicago, Ill.
W. B. Hough, O. A. Kruetzberg, C. L. Rodgers, A. Beroth, L. Place, M. C. Tomkins.
Brandell Concrete Block Machine Company, Chicago, Ill.
W. B. Myers, H. Pool, M. Bissington, F. J. Fitzsimmon, A. R. Cole, A. V. Cauger.
Northwestern Expanded Metal Company, Chicago, Ill.
C. F. Dynes, E. H. Jones, L. Moriarity, A. Tobin.
Pettyjohn Company, Terre Haute, Ind.
William Dunson, Leon Dunn, W. B. Abbey, R. E. Brooks, L. Pettyjohn.
St. Louis Portland Cement Company, St. Louis, Mo.
A. H. Craney, A. Baumberger.
Peerless Block Machine Company, Minneapolis, Minn.
L. V. Thayer, P. Murphy, R. A. Goodwin.
T. Shea, Boston, Mass.
Concrete Publishing Company, Detroit, Mich.
E. R. Kranich, W. C. Boynton, R. Marshall, J. H. Twitchell, E. B. Wolfrom.
Besser Manufacturing Company, Alpena, Mich.
J. H. Besser, W. R. McPhee.
Ballou Manufacturing Company, Belding, Mich.
Simpson Cement Company, Columbus, O.
H. G. Simpson, B. L. Simpson.
Chase Foundry & Manufacturing Company, Columbus, O.
S. M. Chase, W. C. Stocklin.
National Builder, Chicago, Ill.
P. J. Johnson, G. A. Fargher, M. Babcock, J. H. Smith, F. D. Porter.
Expanded Metal and Corrugated Bar Company, St. Louis, Mo.
W. C. Berry, A. E. Lindau, F. Sinks, A. C. Roth.
Diamond Concrete Machine Company, Deshler, O.
D. A. Hopkinson, S. A. Jones.
Miracle Pressed Steel Company, Minneapolis, Minn.
B. F. Rhodehamel.
Ironite Company, Chicago, Ill.
P. S. Brown, J. E. Shakespeare, G. Wahl, John Ross, J. M. Ranhoff.
Fisher Hydraulic Stone & Manufacturing Co., Baltimore, Md.

Blaw Collapsible Steel Center Company, Pittsburg, Pa.
Jacob B. Blaw, A. J. Lowry, J. Murray, R. Wingfield.
Municipal Engineering & Contracting Company, Chicago, Ill.
A. J. Dinkle, J. Warning.
R. Z. Snell Manufacturing Company, South Bend, Ind.
R. Z. Snell, A. Hensberger, H. S. Lagoung, S. C. Santz, H. Snell, S. J. Stratton.
American Cement Roofing Company, Columbus, Ohio.
August Glauss, Henry Baden.
Contractors Supply & Equipment Company, Chicago, Ill.
E. W. Myer, F. B. Wright, W. J. Buckley, J. M. Trevor, F. A. Peterson, J. E. Symons, T. Behan, M. Fleming.
Atlas Portland Cement Company, New York, N. Y.
P. Austen Tomes, F. C. Boyer, F. W. Clayton, J. E. Evans, F. C. Bayley, J. W. Partridge.
Edmonson Concrete Machine Company, South Bend, Ind.
W. G. Elliot, M. M. Ferree, J. H. Willey, F. Kinzie, J. Bowman..
Standard Machine Company, Kent, Ohio.
A. F. Post, E. M. Barber.
Knickerbocker Company, Jackson, Mich.
R. B. Coltran, W. F. Raymond.
American Cement & Roofing Company, Columbus, Ohio.
J. E. Hicks, Charles Spenny.
Nodamp Concrete Machine Company, Minneapolis, Minn.
J. Miller, G. McDonald, G. P. Anderson, D. J. Ames.
Popular Block Company, Minneapolis, Minn.
A. E. Jones, A. L. Wilson, G. A. Beck, L. Wilson.
Clinton Wire Cloth Company, New York, N. Y.
H. Smith, C. F. Fairbank, W. P. Smith.
United Cement Machine Company, Columbus, O.
C. E. Milond, S. M. Coe, H. Mitchell, E. E. Stare, William Krondell, F. McDowell.
Illinois Gravel Company, Princeton, Ill.
L. H. Scott, A. M. Haight, L. Sodirstrom, J. Backman, A. J. Fisher.
Simplex Manufacturing Company, Jackson, Mich.
E. C. Volney, C. Whitney, A. C. Dannfeld, C. O. White, R. Campbell, L. A. Smith.

Ideal Concrete Machine Company, South Bend, Ind.
M. Wetzstein, G. B. Pulfer.
H. F. Behrle, Detroit, Mich.
National Concrete Machine Company, Milwaukee, Wis.
H. F. Behill, R. M. Hodges, V. Rodgest, W. Johns, J. B. Whithall.
Automatic Tamper Company, Peoria, Ill.
G. W. Kramer, O. W. Kramer, John B. Martin, R. L. Rhea.
F. W. Dunn Company, Chicago, Ill.
C. Holm.
Garden City Sand Company, Chicago, Ill.
W. E. Dunn, Chicago, Ill.
R. J. Schwab & Sons Company, Milwaukee, Wis.
R. L. Schwab, G. Gabeb, J. Stumpf, A. Richard, E. S. Waldo.
A. C. McClurg & Co., Chicago, Ill.
F. W. Wilson, J. M. Youngman, E. W. Oswald, R. N. Worsley.
Sandusky Portland Cement Company, Sandusky, O.
Multiplex Machine Company, Toledo, O.
B. Blythim.
Hayden Block Machine Company, Columbus, O.
F. J. Morse, L. J. Moss, R. R. Fish, P. B. Berry.
W. M. Scott, Mrs. M. Scott, G. Black.
Coltrim Manufacturing Company, Jackson, Mich.
F. C. Manier, C. C. Helling, C. G. Boos, W. D. Snyder, J. Dunlap, W. H. Smith, R. Dickenson, G. N. Henderson, W. H. Eccles, Robert Siebert.
Century Cement Machine Company, Rochester, N. Y.
A. T. Bradley, O. D. Tiffany, H. R. Morton.
E. L. Kleiderer, Henderson, Ky.
William Neadstine, Mound City, Ill.
Youngstown Iron, Steel & Roofing Company, Youngstown, Ohio.
John O. Pugh.
United States Concrete Machine Company, Detroit, Mich.
Charles Upton.
Standard Waterproofing Company, Indianapolis, Ind.
G. G. Fry, O. F. Mann.

Sterling Wheelbarrow Company, Chicago, Ill.
C. A. Baker.
Chicago Builders Specialty Company, Chicago, Ill.
H. M. Capron, B. H. Bisbee, H. Baker.
Engineering World, Chicago, Ill.
J. Thompson.
United States Concrete Machine Company, Detroit, Mich.
William Robinson, J. Sullivan, L. H. Brown, M. Lune.
National Cement Machine Works, Bay City, Mich.
J. A. McDonald, H. Black.
Marquette Cement Manufacturing Company, La Salle, Ill.
T. C. Dickinson, T. C. Erringer.
Clover Leaf Machine Company, South Bend, Ind.
W. O. Williams.
Trussed Concrete Steel Company, Chicago, Ill.
William G. Cook.
Addison Brannin, Aberdeen, Miss.
Concrete Edge Protector Company, Detroit, Mich.
E. F. Glock.
The Iron Age, Chicago, Ill.
T. J. Wright.
William H. Nixon, Walkerton, Ind.
F. Bairstow, Waukegan, Ill.
Little & Gavett, Ithaca, N. Y.
Virgil F. Little.
H. F. Wolpenn, Sharm, Wis.
J. C. Dull, Kendall Mt., Canada.
John Downs, Ft. Madison, Ia.
W. Kennedy, Medina, O.
G. R. Wanner, Medina, O.
W. F. Keller, South Bend, Ind.
Medina Concrete Company, Medina, O.
Clare R. Warner.
Martin T. Roche, St. Paul, Minn.
H. C. Wolfram, Sharon, Wis.
Ingersoll-Rand Company, Chicago, Ill.
R. W. Rusterholz.
The Roman Stone Company, Toronto, Can.
G. B. Ashcroft

American Lumberman, Chicago, Ill.
W. C. Howe, Frank Roderus.
F. A. Smith, Chicago, Ill.
W. N. Richter, Rochester, Ind.
George J. Hamill, Bayside, N. Y.
Frederick Fisher, Milwaukee, Wis.
Meixel Bros., Mishawaka, Ind.
Shope & Burt, Maxwell, Iowa.
D. McDonald, Petoskey, Mich.
S. D. Austin, Milwaukee, Wis.
Orlando J. Bowen, Harvey, Ill.
Charles Mankedick & Sons, Sullivan, Ind.
    Charles Mankedick, A. H. Mankedick, W. H. Mankedick.
W. H. Allen, Parsons, Kansas.
Arthur J. Maynard, State Farm, Mass.
Cement Block & Roofing Company, Kenton, O.
    Karl W. Lick.

LIST OF EXHIBITORS, THIRD CONVENTION.

American Carpenter and Builder, Chicago, Ill.
American Cement Roofing Company, Columbus, O.
American Hydraulic Stone Company, Denver, Col.
American Steel and Wire Company, Chicago, Ill.
American Wire Fence Company, Chicago, Ill.
Anchor Concrete Stone Company, Rock Rapids, Iowa.
Ashland Steel Range & Manufacturing Company, Ashland, O.
Atlas Portland Cement Company, Chicago, Ill.
Automatic Tamper Company, Peoria, Ill.
Avery Scale Company, North Milwaukee, Wis.
Ballou Manufacturing Company, Belding, Mich.
Barrett Manufacturing Company, Chicago, Ill.
Besser Manufacturing Company, Alpena, Mich.
Birnstock, W. W., York, Pa.
Blaw Collapsible Steel Center Company, Pittsburg, Pa.
Bovee Furnace and Grinder Works, Waterloo, Ia.
Brandell Concrete Block Machine Company, Chicago, Ill.
Cement Age, New York, N. Y.
Cement Brick Company, Port Huron, Mich.
Cement & Engineering News, Chicago, Ill.
Cement Era, Chicago, Ill.
Cement Machinery Company, Jackson, Mich.
Cement Tile Machinery Company, Waterloo, Ia.
Century Cement Machine Company, Rochester, N. Y.
Chase Foundry & Machine Company, Peoria, Ill.
Chicago Builders Specialty Company, Chicago, Ill.
Chicago Portland Cement Compny, Chicago, Ill.
Clinton Fireproofing Company, Clinton, Mass.
Clover Leaf Machine Company, South Bend, Ind.
Coltrin Manufacturing Company, Jackson, Mich.
Complete Artificial Stone Company, Chicago, Ill.
Concrete Edge Protector Company, Detroit, Mich.

Concrete Publishing Company, Detroit, Mich.
Concrete Stone & Land Company, Youngstown, O.
Concrete Stone Machine Company, Kansas City, Mo.
Contractors Supply & Equipment Company, Chicago, Ill.
Diamond Cement Machine Company, Deshler, O.
Fred W. Dunn, Chicago, Ill.
W. E. Dunn & Co., Chicago, Ill.
Dykema Company, Grand Rapids, Mich.
Edison Portland Cement Company, Stewartsville, N. J.
Edmondson Machine Company, South Bend, Ind.
Eureka Machine Company, Jackson, Mich.
Expanded Metal & Corrugated Bar Company, St. Louis, Mo.
Fisher Hydraulic Stone & Machinery Company, Baltimore, Md.
Garden City Sand Company, Chicago, Ill.
Hartwick Machinery Company, Jackson, Mich.
Hayden Automatic Block Machine Company, Columbus, O.
William B. Hough Company, Monadnock Building, Chicago, Ill.
Ideal Concrete Machinery Company, South Bend, Ind.
Illinois Gravel Company, Princeton, Ill.
Indiana Road Machine Company, Chicago, Ill.
International Fence & Fireproofing Company, Columbus, O.
International Harvester Company, Chicago, Ill.
Iowa Building Block Machine Company, Waterloo, Ia.
Ironite Company, Chicago, Ill
Knickerbocker Company, Jackson, Mich.
Arthur Koppel Company, Chicago, Ill.
Lehigh Portland Cement Company, Allentown, Pa.
Luck Cement Post Company, Aurora, Ill.
A. D. Mackay & Co., Chicago, Ill.
Marquette Cement Manufacturing Company, Chicago, Ill.
Miracle Pressed Stone Company, Minneapolis, Minn.
Multiplex Concrete Machine Company, Toledo, O.
Municipal Engineering & Contracting Company, Chicago, Ill.
A. C. McClurg & Co., Chicago, Ill.
National Builder, Chicago, Ill.
National Cement Machine Company, Bay City, Mich.
National Concrete Machinery Company, Milwaukee, Wis.
Never Rot Post Company, Westerville, O.

New Way Motor Company, Lansing, Mich.
Noble, J. A., Fostoria, O.
Northwestern Expanded Metal Company, Chicago, Ill.
Non-Staining Cement Company, New York, N. Y.
Northwestern Steel & Iron Works, Eau Claire, Wis.
Nodamp Concrete Block Machine Company, Minneapolis, Minn.
Ormsby, George S., Xenia, O.
Peerless Brick Machine Company, Minneapolis, Minn.
Perfection Block Machine Company, Minneapolis, Minn.
Popular Block Machine Company, Minneapolis, Minn.
Queen City Brick Machine Company, Traverse City, Mich.
H. S. Quick & Co., Indianapolis, Ind.
St. Louis Portland Cement Company, St. Louis, Mo.
R. L. Rhea, Peoria, Ill.
Runyon Concrete Machine Manufacturing Co., Cleveland, O.
Sandusky Portland Cement Company, Sandusky, O.
R. J Schwab & Sons, Milwaukee, Wis.
Simplex Manufacturing Company, Jackson, Mich.
Simpson Cement Mold Company, Columbus, O.
Sixbey & Grumme, Portland, Ind.
Snell Manufacturing Company, South Bend, Ind.
South Bend Machine Manufacturing Company, South Bend, Ind.
Standard Machine Company, Kent, O.
Standard Waterproofing Company, Indianapolis, Ind.
Star Cement Block Machine Company, Dallas City, Ill.
Sterling Wheelbarrow Company, Milwaukee, Wis.
Stevens Cast Stone Company, Harvey, Ill.
Stringer Machine Company, Jackson, Mich
Stumpf & Richards, Milwaukee, Wis.
The Pettyjohn Company, Terre Haute, Ind.
United Cement Machinery Manufacturing Co., Columbus, O.
United States Cement Machine Company, Deshler, O.
United States Machinery Manufacturing Co., Columbus, O.
Universal Portland Cement Company, Rookery Bldg., Chicago.
Wettlauffer Bros., Buffalo, N. Y.
White Cement Machinery Company, Jackson, Mich.
Whitefall Portland Cement Company, Philadelphia, Pa.
Winget Concrete Machine Company, Columbus, O.

Winner Block Machine Company, Minneapolis, Minn.
X. L. Concrete St. Machinery Company, Kansas City, Mo.
Youngstown Iron & Steel Roofing Company, Youngstown, O.

REPORT OF THE EXECUTIVE BOARD OF THE NATIONAL ASSOCIATION OF CEMENT USERS FOR THE YEAR ENDING JANUARY 11, 1907.

Members National Association of Cement Users:

GENTLEMEN:—In accordance with the requirements of the By-Laws, your Executive Board presents the following report for the past year:

CONVENTION:—In determining the place for the convention your Executive Board had in mind the vote of the members at the Milwaukee Convention, which gave Chicago the first choice and Columbus second choice.

Negotiations were taken up with these two cities early in April; both cities were visited, the city of Columbus finally agreeing to provide certain facilities without cost to the Association, should the Executive Board elect to hold the convention in that city.

The city of Chicago also took the matter under consideration, and after carefully considering, agreed to the proposition of the city of Columbus in part in the latter part of the summer.

The Executive Board at its meeting on August 24, 1906, decided that, inasmuch as the convention for 1907 would doubtless be the largest in the history of the Association, the space available for exhibits in Memorial Hall, Columbus, would be inadequate, and therefore selected the city of Chicago because of its greater facilities.

It was believed that the Secretary of the Association should be located in the city in which the convention was going to be held, and for this reason it delayed the selection of a secretary until this matter could be definitely settled.

Accordingly, the Executive Board left the selection of a Secretary in the hands of the President, the idea being to select a Chicago man. Mr. H. C. Turner, of New York, was elected Treasurer at this meeting of August 24. 1906. The President was also instructed to take up the matter with the city of Chicago and make definite arrangements for the convention.

When an attempt was made to enter into a definite agreement with the city of Chicago they were disinclined to assume the responsibilities of managing the convention themselves and offered the Association $3,000 in cash for defraying all expenses which would be necessary for securing a hall and providing proper facilities for handling the convention. This matter the President referred to the Executive Board, which, at its meeting on October 25, ratified this proposition and also elected Mr. W. W. Curtis, of Chicago, Secretary of the Association.

Of the facilities offered by the two cities in question, the city of Chicago, while not fulfilling altogether those desired by the Executive Board, seemed to offer the greatest inducement, and therefore the convention is being held in this city.

The following statement shows the present condition of the finances of the Association for the fiscal year ending December 31, 1906:

Balance on hand		$160.93
RECEIPTS.		
Full memberships at $5.00 (1906)	$1,088.15	
Convention memberships at $2.00 (1906)	244.00	
Sale exhibit space at 1906 Convention	1,648.50	
Railroad refund on account of railroad certificates	39.60	
Electro	.20	
Sale of Proceedings and postage, 1906 and 1905	1.20	
Advertising in 1905 Proceedings	218.00	
Advertising in 1906 Proceedings	44.00	
		3,444.58
		$3,605.51
DISBURSEMENTS.		
Office expenses	$386.25	
Traveling expenses	341.82	
Stationery and printing	415.95	
Publication 1905 Proceedings	367.05	
Postage, telegraph and express	189.65	
Convention expenses (Milwaukee, 1905)	513.07	
Exhibition expenses (Milwaukee, 1906)	299.79	
Incorporation	14.12	
Miscellaneous expenses	19.00	
		2,556.68
		$887.90
Interest on deposit		2.79
Balance on hand		890.69

It will be noted that the amount of money turned over to the Association at the end of the Indianapolis Convention was: The balance, January 1, 1906, was $160.93, while the balance, January 1, 1907 is $890.69. The expenses in connection with this convention will be provided for as in the case of the previous years, and are, therefore, not a part of the financial statement for the fiscal year ending January 1, 1907.

The membership of the Association at the end of the Indianapolis Convention was 161 as per full memberships paid; at the end of the Milwaukee Convention there were 218 full members and 121 convention members. The present indications are that the membership at the close of this convention will be larger than ever before.

INCORPORATION:—At the last meeting of the Annual Convention of the Association the Executive Board was instructed to incorporate, and this has been done under the laws of the District of Columbia. It was found that the laws of the District of Columbia required that the majority of the incorporators should be resident in the District, and this necessitated increasing the membership so as to meet this requirement, and this naturally caused some delay in taking out the papers for incorporation.

PROCEEDINGS OF MILWAUKEE CONVENTION:—By resolution of the Executive Board, the proceedings of the Milwaukee Convention was to be in the hands of the President within thirty days after the close of the convention, and were to be published within sixty days thereafter. Inasmuch as a great deal of labor was required to get them in shape for publication and by reason also that the amount of advertisements secured was insufficient to fully pay for the publication, it was impossible to comply with this resolution. Besides, the Executive Board believed that the proceedings should be published without incurring any debt, and, therefore, turned the entire matter over to the President, with power to act. The total cost of the proceedings will be about $700. The advertising contracts amount to over $700. The Proceedings of the Indianapolis Convention have but 170 pages, with no illustrations and 17 advertisements; the Proceedings of the Milwaukee Convention will contain over 300 pages, 30 illustrations and 50 advertisements.

The proceedings have been printed, and we have been informed that they have been shipped here and we are expecting them momentarily. The delay in the issuance of these proceedings is regrettable, but it has been in the best interests of the Association.

BOARD MEETINGS:—The Executive Board, as at present constituted, consists of fifteen members, thus necessitating an attendance of not less than eight to secure a quorum at any meeting. Inasmuch as the members of the Board are widely scattered and, further, since the members are obliged to pay their own expenses in attending these meetings, it has been found impracticable to secure a quorum at any time except during the Annual Convention.

It is hardly reasonable to expect busy men to contribute, not only their time, but to pay personally all the expenses of the Board meetings. It appears to the Board that this Association should make some equitable provision for these expenses.

The Executive Board until the present time has not felt justified, in view of the limited funds of the Association, in allowing the Secretary any compensation for his services, other than the necessary traveling expenses in attending Board meetings.

Your Board asks authority to express the appreciation of the Association and the Executive Board for the services rendered by the first secretary of the Association, Mr. Charles Carroll Brown, and to vote him an honorism of $300.

Submitted on behalf of the Executive Board,

RICHARD L. HUMPHREY,
President.

W. W. CURTIS,
Secretary.

MINUTES OF THE EXECUTIVE BOARD MEETINGS.

In accordance with the provisions of the By-Laws the minutes of the meetings of the Executive Board are appended herewith:

MINUTES OF THE MEETING HELD AT MANHATTAN BEACH HOTEL, MANHATTAN BEACH, N. Y., AUGUST 24, 1906.

The Executive Board National Cement Users Association met, pursuant to call by President and Secretary, in the Manhattan Beach Hotel, 3 p. m., August 24, 1906. Members present: President Richard L. Humphrey, First Vice-Presidents Merrill Watson, O. U. Miracle M. S. Daniels, E. S. Larned.

On motion of Mr. Watson, seconded by Mr. Daniels, in the absence of the Secretary, Mr. C. C. Brown, Mr. O. U. Miracle acted as Secretary *pro tem.* of the meeting.

On motion of Mr. Watson, seconded by Mr. Daniels, the position of Secretary was declared vacant.

It was moved by Mr. Watson, seconded by Mr. Miracle, that the thanks of the Board be tendered to Mr. C. C. Brown for his services in the organization of this Association and as the first secretary thereof.

On motion of Mr. Larned, seconded by Mr. Watson, Mr. H. C. Turner, No. 11 Broadway, New York, was elected Treasurer of this Association.

President Humphrey appointed as Auditing Committee Messrs. Daniels, Watson and Fellows.

On motion of Mr. Watson, seconded by Mr. Daniels, the Secretary *pro tem.*, Mr. Miracle, was instructed to notify Mr. Brown to deliver to Mr. M. S. Daniels, Chairman of the Auditing Committee, No. 24 State Street, New York, all the records

of the Association now in his possession, including correspondence, minutes, records and others files, a statement of all assets and liabilities, vouchers, treasurer's and all other receipts, and all moneys held by him as custodian, and vouchers and inventories of all furniture and fixtures in his possession, within fifteen days from date.

It was moved by Mr. Daniels, seconded by Mr. Watson, that Mr. Gammon be notified to submit complete report of receipts, disbursements and draft for balance on hand to Mr. M. S. Daniels, Chairman of the Auditing Committee, No. 24 State Street, New York.

On motion of Mr. Daniels, seconded by Mr. Larned, the President was instructed to take the necessary steps to incorporate this Association under the laws of the District of Columbia.

On motion of Mr. Daniels, seconded by Mr. Watson, the President was authorized to publish proceedings of the last annual convention, all details of the same being left to his discretion, with full power to act. Total issue of proceedings to be governed by amount realized from advertising.

On motion of Mr. Watson, seconded by Mr. Daniels, the back cover page of the proceedings was awarded to the Association of American Cement Manufacturers for advertising purposes.

On motion of Mr. Daniels, seconded by Mr. Watson, the President was appointed a committee of one to prepare a program for the next annual meeting, and submit the same to the Executive Board.

On motion of Mr. Daniels, seconded by Mr. Larned, the President was empowered to further investigate the facilities of the various cities for holding the next annual convention.

On motion of Mr. Larned, seconded by Mr. Watson, the date of the next annual convention was left to the President to determine, after securing more information relative to place of meeting—preference being given to weeks beginning January 7 or 22, 1907.

On motion of Mr. Larned, seconded by Mr. Daniels, the Secretary and Treasurer were required to give bonds of $5,000

each, said bonds to be filed with trustees, consisting of the President, Mr. Richard L. Humphrey, and Messrs. M. S. Daniels, Merrill Watson.

Board adjourned to meet at call of President.

RICHARD L. HUMPHREY,
President.

O. U. MIRACLE,
Secretary pro tem.

MINUTES OF THE MEETING HELD AT HOUSE OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS, NEW YORK, OCTOBER 25, 1906.

The Executive Board, National Association of Cement Users, met, pursuant to call of President, at the house of American Society of Civil Engineers, 220 West Fifty-seventh Street, New York, at 10.35 a. m., October 25, 1906, those present being: President Richard L. Humphrey, First Vice-Presidents Merrill Watson, John H. Fellows, M. S. Daniels, E. S. Larned.

On motion of Mr. Watson, Mr. E. S. Larned was chosen Secretary *pro tem.* Minutes of last meeting of August 24, 1906, were read and put in proper sequence, and no correction or objections being noted, they were declared approved.

PUBLICATION OF PROCEEDINGS:—The following resolution (offered by Mr. Watson, seconded by Mr. Fellows) was carried:

WHEREAS, President Humphrey reports to the Board that, in carrying out its orders in publishing the proceedings of the last annual convention, there have been secured approximately $700 of contracts for advertising, but that part of these, together with copy and cuts for same, are in the hands of Mr. C. C. Brown, late Secretary of the Association; be it

Resolved, That Mr. Brown be and is hereby requested to forward at once to Mr. Richard L. Humphrey, at St. Louis, all contracts, correspondence, copy, cuts and other matter pertaining to the proposed publication of proceedings in his possession.

The letter from A. Monsted resigning from Executive Board because of inability to attend its meetings was considered. On motion of Mr. Daniels, seconded by Mr. Watson, the Secretary of the meeting was directed to notify Mr. Monsted that it was the wish of the Board that he retain office at least until the close of next Convention, and, accordingly, the resignation was laid on the table.

ANNUAL CONVENTION:—On motion of Mr. Watson, seconded by Mr. Fellows, the contract for Convention Hall, in Chicago, from January 6 to January 13, 1907, was approved, and the President, Richard L. Humphrey, was directed to close same in behalf of the Association.

On motion, the Secretary was instructed to prepare and furnish all announcements relating to the Annual Convention under approval of the President, and to furnish same to technical and other publications.

It was moved and carried that the "Exhibition of Machinery, Cement Products, etc., in connection with the Convention of the N. A. C. U. shall open on Monday, January 7, 1907, and that no exhibitor shall be permitted to pack or remove any machine or product earlier than noon of Saturday, January 12, 1907, and that an admission fee of twenty-five cents shall be charged all visitors not members of the Association, or exhibitors. The Association to issue to each exhibitor not more than six passes to properly accredited attendants upon the exhibits."

It was also agreed that the Convention be called to order by the President at 10 a. m. Tuesday, January 8, 1907, subsequent sessions to be as follows:

Tuesday, January 8, 8 P. M.
Wednesday, January 9, 9 to 10 A. M., Experience Meeting.
Wednesday, January 9, 10 A. M., business.
Wednesday January 9, 1 P. M., visit to cement works.
Wednesday, January 9, 8 P. M., business.
Thursday, January 10, 10 A. M.
Thursday, January 10, 8 P. M., social entertainment.
Friday, January 11, 10 A. M.
Friday, January 11, 8 P. M., evening session.

On motion of Mr. Daniels, seconded by Mr. Fellows, Mr. E. T. Cairns was elected Vice-President of section on "Fireproofing and Insurance," Mr. H. C. Henley was elected Vice-President of section on "Laws and Ordinances," and Mr. J. F. Angell was elected Vice-President of section on "Machinery for Cement Users."

On motion of Mr. Watson, seconded by Mr. Fellows, all arrangements for renting exhibit space (at not less than ten cents per square foot) was left to President, with power to act.

On motion of Mr. Fellows, seconded by Mr. Watson, the President was directed to arrange for and settle the overpayment of the stenographer at Milwaukee Convention, amounting to $80.80, and report.

President reported progress on the incorporation of the Association, and stated that the same will be ready for signatures in course of two weeks.

On motion of Mr. Larned, the report of Auditing Committee (Messrs. Fellows, Watson and Daniels, Chairman) on the former Treasurer's account was accepted and placed on file, and the Auditing Committee was instructed to transmit to Treasurer Mr. H. C. Turner, No. 11 Broadway, New York City, the funds reported in their possession, amounting to $996.30.

On motion of Mr. Fellows, seconded by Mr. Larned, Mr. C. C. Brown's report of receipts and disbursements be referred back to the Auditing Committee for further investigation and report.

Application of Mr. W. W. Curtis, Chicago, Ill., submitted and approved for membership.

On motion of Mr. Daniels, seconded by Mr. Fellows, Mr. W. W. Curtis, Chicago, Ill., was appointed Secretary of the National Association of Cement Users, his compensation as Manager of the Convention not to exceed $400, to cover completion of all Convention work, including clerk hire, office rent, etc., but not including stationery, postage, telegrams and like expenses.

On motion of Mr. Daniels, seconded by Mr. Fellows, the President, Richard L. Humphrey, was empowered and directed to dispose of such furniture and fixtures of the Association as are not needed by the Secretary to the best advantage, and turn in to the Treasurer memorandum and receipts therefor.

Adjourned 4.20 p. m. October 25, 1906.

RICHARD L. HUMPHREY,
President.

E. S. LARNED,
Secretary Pro tem.

MINUTES OF THE MEETING HELD AT THE AUDITORIUM HOTEL, CHICAGO, ILL., JANUARY 7, 1907.

The Executive Board, National Association of Cement Users, met, pursuant to call of President, in the Auditorium Hotel, Chicago, Ill., at 9 p. m., January 7, 1907. Members present: President Richard L. Humphrey, First Vice-President Merrill Watson, Third-Vice-President O. U. Miracle, Fourth Vice-President A. Monsted, Secretary W. W. Curtis, Treasurer H. C. Turner, Messrs. M. S. Daniels, George L. Stanley, T. L. Condron, Charles D. Watson, E. S. Larned.

It was moved by Mr. Watson and seconded by Mr. Daniels that the minutes as read of the meeting held at Manhattan Beach, August 24th, be approved, and that the action taken at that meeting be ratified and approved at this meeting. Unanimously carried.

The minutes of the meeting of October 25th, held in New York City, were then read by the Secretary.

After correction, the minutes were approved, and the action taken at that meeting was ratified by unanimous vote.

Mr. Daniels, of the Auditing Committee, reported that there were four unsigned vouchers in the records of Mr. Brown—Nos. 29, 30, 31 and 39. It was moved by Mr. Charles D. Watson, seconded by Mr. Merrill Watson, that the President be authorized to approve all unsigned vouchers as rendered by Mr. C. C. Brown, which was unanimously agreed to.

The report of the Auditing Committee was then read, as follows:

JANUARY 7, 1907.

The Auditing Committee reports that it has examined the vouchers and acts of the late Secretary, Mr. C. C. Brown, and find that the same are correct.

M. S. DANIELS,
MERRILL WATSON.

On motion, the report as read was accepted and placed on file.

Moved by Mr. Larned, seconded by Mr. C. D. Watson, that no arrearages of dues of members be canceled. Carried.

It was moved and seconded that the acts and decisions of the President and Secretary as to badges and admissions be approved. Carried.

It was agreed to refer to the President and Mr. Hager the arrangements for Thursday evening.

On motion, the action of the President paying the bill of stenographer for the Milwaukee Convention was unanimously approved.

The surety bonds of the Secretary and Treasurer being presented by the President, on motion of Mr. Merrill Watson, seconded by Mr. Condron, they were approved.

A committee consisting of the President, Secretary and Mr. Daniels was appointed to prepare the annual report.

Adjourned to 10 p. m. January 8th.

RICHARD L. HUMPHREY,
President.

W. W. CURTIS,
Secretary.

MEETING OF THE EXECUTIVE BOARD, NATIONAL ASSOCIATION OF CEMENT USERS, HELD 10 P. M. JANUARY 8, 1907, PURSUANT TO ADJOURNMENT.

Present: Messrs. Humphrey, Daniels, Larned, Stanley, Watson, Watson, Turner, Curtis.

Mr. Larned moved that the President be directed to request Mr. Dickinson to remit the balance due on the guarantee of $3,000 to secure the Convention for Chicago. Seconded by Watson. Carried. Moved and seconded that unpaid voucher be approved and ordered paid.

Moved by Mr. Daniels and seconded by Mr. Watson that action of the President and Secretary in engaging assistance for the convention be approved. Carried.

On motion by Mr. Turner the report of the Executive Board to be presented at the business session Wednesday noon, January 9th, was unanimously adopted.

Moved by Mr. Daniels, seconded by Mr. Stanley, that the Treasurer be instructed to deposit the funds of the Association in the Bankers' Trust Company of New York, to be paid out on the Treasurer's signature on vouchers, when attested by the Secretary and countersigned by the President.

Adjourned to January 10, 1907.

RICHARD L. HUMPHREY,
President.

W. W. CURTIS,
Secretary.

MINUTES OF THE MEETING HELD AT THE AUDITORIUM, CHICAGO, ILL., JANUARY 10, 1907.

The meeting of the Executive Board was held, in accordance with adjournment, at the Auditorium Hotel, Chicago, Ill. January 10, 1907.

Present: President Humphrey and Messrs. Daniels, Stanley, Merrill Watson, Charles D. Watson, Larned and Curtis.

It was moved and seconded that each member of the Board investigate the facilities of their nearest cities with reference to the accommodations for the next Convention and report to the President within thirty days, this information to be compiled by him and submitted to the Board for consideration and decision. Carried.

On motion, duly seconded, it was agreed that the price of $1 be put upon the 1905 proceedings; $3 on the 1906 proceedings, or $2 for additional copies thereof to members. Price for the 1907 proceedings to be $3 to non-members and $2 for extra copies to members. Convention members to be considered as non-members so far as proceedings are concerned.

It was moved and seconded that the Secretary prepare a circular giving the price of the proceedings and also notify the convention members that if they pay the additional amount of $3 prior to March 1, 1907, they will be transferred to full membership and will receive the proceedings of the 1907 Convention. Carried.

On motion, the President was authorized to engage assistance at such compensation as he considers best.

On motion, duly seconded, it was resolved that it is the opinion of the Executive Board that it is inexpedient at this time to create a new section on Water Proofing. Carried.

On motion, duly seconded, a committee on the standardization of specifications was appointed, consisting of the President of this Association, *ex-officio*, the Vice-President and members of the section on "Tests of Cement and Cement Products," and the Vice-President of each of the followed named sections, viz: Concrete Blocks and Cement Products; Streets, Sidewalks and

Floors, Reinforced Concrete; Art and Architecture; Machinery for Cement Users; Fireproofing and Insurance; Laws and Ordinances. The above committee to meet and organize before the close of this convention and copy of their report and recommendations to be prepared and sent to each member of this Association on or before the first day of June, 1907, for consideration in advance of the next Annual Convention.

Adjourned to January 11, 1907.

RICHARD L. HUMPHREY,
President.

W. W. CURTIS,
Secretary.

MINUTES OF THE MEETING HELD AT THE AUDITORIUM HOTEL, CHICAGO, ILL, JANUARY 11, 1907.

A meeting of the Executive Board was held, in accordance with adjournment, at the Auditorium Hotel, Chicago, Ill., January 11, 1907. Present, President Richard L. Humphrey, Messrs. Condron, Daniels, Larned, Miracle, Stanley, Merrill Watson, Charles D. Watson and Curtis.

Moved by Mr. M. Watson that the Executive Board meet at such place as the President may find most convenient to the members as soon as possible after March 15. Carried.

Minutes of the meeting held on the 10th instant read and on motion were approved.

Adjourned *sine die*.

RICHARD L. HUMPHREY,
President.

W. W. CURTIS, *Secretary*.

LIST OF MEMBERS.

ACME CEMENT BLOCK Co., Wellsburg, W. Va.

ADAMS, ADOLPH, Kendallville, Ind.

ADAMS, J. H., Beloit, Wis.

ALPHA PORTLAND CEMENT Co., Easton, Pa.

ALTOONA CONSTRUCTION AND CONTRACTORS' SUPPLY Co., Altoona, Pa.

ALTON ROOFING, ARTIFICIAL STONE AND SUPPLY HOUSE, Alton, Ill.

AMERICAN CEMENT COMPANY, 604 Penn Building, Philadelphia, Pa.

AMERICAN CLAY MACHINERY COMPANY, Willoughby, Ohio.

AMERICAN HYDRAULIC STONE Co., Century Building, Denver, Colo.

AMERICUS TILE AND ARTIFICIAL STONE Co., Americus, Ga.

ANCHOR CONCRETE STONE Co., 312 Main St., Rock Rapids, Ia.

ANGELL, J. E., United Cement Machinery Mfg. Co., Columbus, Ohio.

ARTIFICIAL CONCRETE AND CONSTRUCTION Co., Evergreen Borough of Queens, N. Y.

ATLANTA CONCRETE MANUFACTURING AND CONSTRUCTION Co., Atlanta, Ga.

BABICZKY, JOSEPH, Guardian Trust Building, Kansas City, Mo.

BAILEY, H. L., City Hall, Chicgo, Ill.

BAILEY, W. W., Chadwick, Ill.

BALYCAT COAL Co., Van Wert, Ohio.

BALLOU MANUFACTURING Co., Belding, Mich.

BARKER & NIGHSWANDER, Jefferson Ave. and Water St., Toledo, Ohio.

BARR, J. L. H., Batavia, Ohio.

BATTJES FUEL AND BUILDING MATERIAL Co., Grand Rapids, Mich.

BEAN, W. WORTH, JR., Benton Harbor, Mich.

BEDELL, H. W., Bloomfield, Ont., Can.

BEIRER, W. & H., 813 E. Sixth St., Alton, Ill.
BELL, WILLIAM, 509 Hill Ave., Elgin, Ill.
BELLEVUE STONE CO., Bellevue, Ohio.
BENDER, A. L., Topeka, Ind.
BENNER, E. E., 217 S. Seventeenth St., Lincoln, Neb.
BERTHELET CONCRETE STONE CO., Milwaukee, Wis.
BESSER MANUFACTURING CO., Alpena, Mich.
BEYER, IRA, Mishicott, Wis.
BINGHAM, L. L., Esterville, Iowa.
BIRNIE, A. C., 467 Broadway, Albany, N. Y.
BLACKBURN, W. L., Hillsboro, Ill.
BLAKE, J. A., 268 Littleton St., West Lafayette, Ind.
BLAKELY, 541 Union St., Centralia, Ill.
BLAKESLEE CONCRETE BLOCK AND MACHINERY CO., 408 Shultz Building, Columbus, Ohio.
BLAW'S COLLAPSIBLE STEEL CENTERING CO., 1414 Penn Ave., Pittsburg, Pa.
BOSSERT, O. N., 54 University Building, Milwaukee, Wis.
BOVEE H., & SON, Northville, Mich.
BOYLAN, H. T., Buchanan, W. Va.
BOYNTON, C. W., Illinois Steel Co., Cement Dept., Commercial National Bank Building, Chicago, Ill.
BRACKER, KARL A., 319 Superior Ave., Dayton, Ohio.
BRAWNIN, ADDISON, Aberdeen, Miss.
BROWN, CHARLES CARROLL, 310 Commercial Club, Indianapolis, Ind.
BROWNELL, Mgr. Keokuk Cement Brick Co., E. H. Bowen, Supt., Keokuk, Iowa.
BUEHLER, JOHN, Portage, Wis.
BURKLEY, FAY H., 162 Farrington Ave., St. Paul, Minn.
BUSER CONCRETE CONSTRUCTION CO., Mount Morris, Ill.
BYRON, M. P., CONSTRUCTION CO., Ninety-fifth St. and Erie Ave., Chicago, Ill.
CALDWELL, C., Winona, Ont., Can.
CANADIAN PETRIFIED BRICK AND STONE CO., Winnipeg, Man.
CAPITAL CITY CONCRETE CONSTRUCTION CO., Springfield, Ill.
CARLSEN, C. J., Care St. Jos. Lead Co., Flat River, Mo.
CARRERE, JAMES MAXWELL, Blanc Stainless Cement Co., 1 Madison Ave., New York City.

CARTHAGE SUPERIOR LIMESTONE Co., Carthage, Mo.

CASTALIA PORTLAND CEMENT Co., 701 Publication Building, Pittsburg, Pa.

CEMENT ERA, Chicago, Ill.

CEMENT AND ENGINEERING NEWS, Chicago, Ill.

CEMENT BRICK Co., Port Huron, Mich.

CEMENT MACHINERY Co., Jackson, Mich.

CEMENT MACHINERY MANUFACTURING Co., Burlington, Iowa.

CEMENT PRODUCTS Co., Burlington, Wis.

CEMENT STONE AND SUPPLY Co., Wichita, Kans.

CENTRAL CONCRETE CONSTRUCTION Co., 81 Todd Building, Louisville, Ky.

CENTURY CEMENT MACHINE Co., 181 W. Main St., Rochester, N. Y.

CHAMBERLIN, C. A., Jackson, Mich.

CHICAGO PORTLAND CEMENT Co., Stock Exchange Building, Chicago, Ill.

CHICKAMAUGA CEMENT Co., Chattanooga, Tenn.

CHRISMAN CONCRETE STONE Co., Chrisman, Ill.

CITY CONSTRUCTION Co., Milwaukee, Wis.

CITY ARTIFICIAL STONE Co., T. W. Stewart, Paris, Ill.

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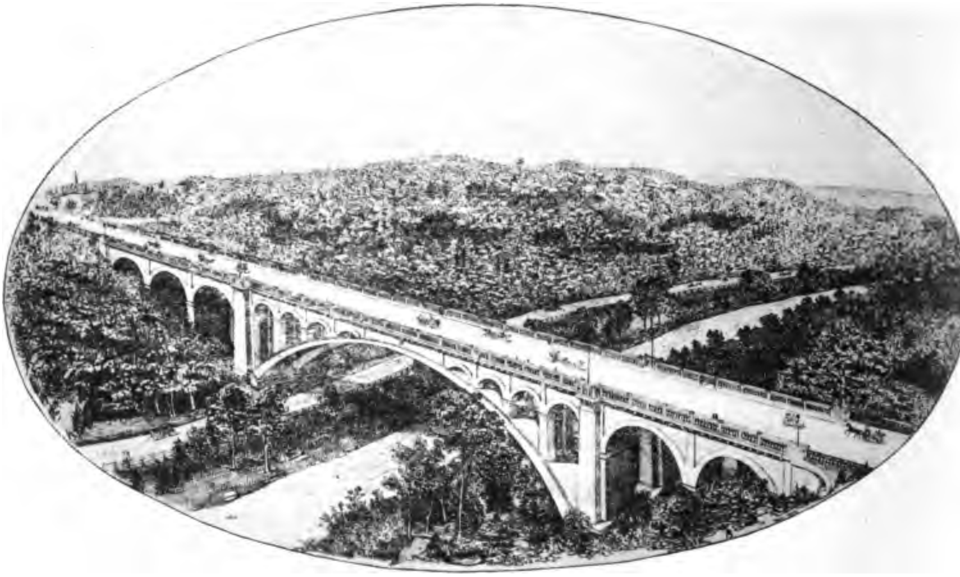

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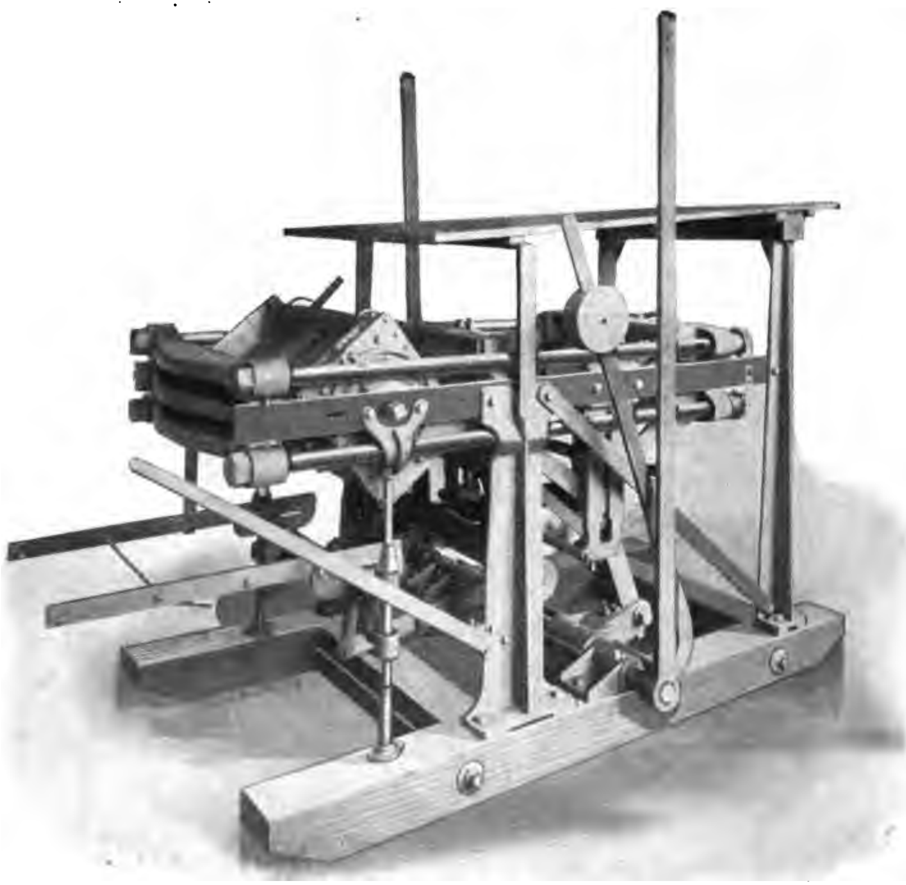

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